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**MEMORANDUM**

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| **To:** | EPA |
| **Copy To:** | File 80021 |
| **From:** | J. Lambert, J. Brunelle |
| **Subject:** | Olin: DAPL Alternative Detailed Analysis R6 |
| **Date:** | 2/21/2020 |

This Technical Memorandum (Memo) provides replacement text for the development, screening, and analysis of remedial alternatives for dense aqueous phase liquid (DAPL) at the Olin Chemical Superfund Site (the Site) in Wilmington, Massachusetts, as requested by the U.S. Environmental Protection Agency (EPA).

Initial alternatives were provided in the Draft Interim Action Feasibility Study (IAFS) prepared by Wood Environment & Infrastructure Solutions (Wood), 2019. The text in this memo is intended to replace sections of the 2019 IAFS as needed.

The DAPL alternatives in this Memo are based on Olin's proposed alternatives that were modified to incorporate a different estimate of the volume of DAPL to be removed, additional extraction wells, and more detailed evaluation of alternatives compared to the criteria outlined in EPA guidance (EPA, 1988). These alternatives are based on current Site data and EPA's current conceptual site model (CSM).

The Remedial Action Objectives (RAOs) these alternatives intend to address include the following:

- Reduce, to the extent practicable, the volume of DAPL and mass of DAPL pool constituents that represent a source of Site contaminants to groundwater, surface water, and sediments.
- Reduce, to the extent practicable, the horizontal and vertical migration of DAPL acting as a source of Site contaminants, including penetration into bedrock via matrix porosity and/or fractures, horizontal and vertical diffusion into aquifer matrices, and back-diffusion of Site contaminants into groundwater from affected aquifer matrices.





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- Prevent human exposure to DAPL containing Site contaminants exceeding Applicable or Relevant and Appropriate Requirements (ARARs) and health-protective, risk-based standards.

Olin is in the process of collecting additional data, including bedrock elevations and topography, and the calculated DAPL volumes and number and arrangement of extraction wells may change based on investigation results and observations during remedy implementation.

The active alternatives for each DAPL pool include two sub-alternatives to include the expected range of treatment. Figure 1A and Figure 1B depict the three DAPL pools and the expected potential range of alternative options.

## 1.0 IDENTIFICATION AND DEVELOPMENT OF ALTERNATIVES: SECTION 3.2.2

DAPL extraction at the Off-Property West Ditch (OPWD) DAPL Pool, also known as the Jewel Drive DAPL pool, has been demonstrated under the DAPL Extraction Pilot Test to be successful when lower DAPL extraction rates are used (less than 0.5 gallons per minute [gpm]) to minimize entrainment of groundwater and groundwater mixing. Therefore, the active remedial alternatives proposed for all three DAPL pools is DAPL extraction and ex-situ treatment.

For comparative purposes, the extracted DAPL is proposed to be treated on-site. Feasibility of DAPL treatment and details of the required treatment trains will be evaluated as part of pre-design investigations (PDIs).

### 1.1 Alternative DAPL 1: No Further Action: Section 3.2.2.1

Alternative DAPL 1 does not include any additional remedial action components to reduce DAPL volume or to control or eliminate potential risks from exposure to DAPL. The No Further Action alternative provides a baseline for comparison with the other alternatives as required by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Contingency Plan (NCP).

### 1.2 Alternative DAPL 2: DAPL Extraction from OPWD DAPL Pool: Section 3.2.2.2

Alternative DAPL 2 addresses the OPWD (Jewel Drive) DAPL Pool. It includes institutional controls for properties above the footprint of the DAPL pools to prevent groundwater use, optimization of the current DAPL extraction system, operations and maintenance (O&M), monitoring, and Five-Year Reviews.

For comparative and initial costing purposes, an estimated DAPL pool volume of 1.3 million gallons was used (Geomega, 2020, Table 4). This estimate was based on the most recent (2019) sampling results.

Alternative DAPL 2 includes one alternative with a minimum number of extraction wells (DAPL 2A) and one with an anticipated maximum number of extraction wells (DAPL 2B) to maximize DAPL removal efficiency as described in the subsections below. The number of extraction wells described in the alternatives below are intended to provide a range. Additional wells may be required in the future based on data collected and observations during remedy implementation.

### 1.2.1 Alternative DAPL 2A

Alternative DAPL 2A includes installation of a new extraction well to replace the existing extraction well (EW-1). The new well will be installed adjacent to EW-1 and construction will include a two-foot screen. The shorter screen may allow slightly improved pumping rates without dilution.

Current subsurface data collected at the Site indicates that the central portion of the DAPL pool is located beneath an existing building within an east-west sloping bedrock depression. The alternative will include installing borings to bedrock on the northeast and southeast side of the building to confirm bedrock elevations and current geophysical data. The topography of the bedrock will determine long-term sustainable recovery rates. These may be greater than 0.25 gpm, depending on the geometry of the pool. Figure 2 depicts potential DAPL extraction wells for comparative and initial costing purposes.

If the general slope of bedrock is confirmed to be east to west, then the current extraction well is located properly for removing DAPL via gravity drainage long-term. Alternative DAPL 2A may not be effective if geophysical data indicates that bedrock conditions do not align with the current bedrock model.

The analysis of alternatives and cost estimate for Alternative DAPL 2A assumes that 95% of the accessible DAPL present in the OPWD DAPL pool (1.235 million gallons) will be recovered and treated on-site.

### 1.2.1 Alternative DAPL 2B

Alternative DAPL 2B includes the components in Alternative DAPL 2A, plus extraction from the lowest point in the basin (assumed to be beneath the center of the building). In addition, Alternative DAPL 2B includes a provision for auxiliary DAPL extraction wells to minimize drawdown, provide flexibility with pumping rates, and target any bedrock low spots identified during system design. Figure 2 depicts potential DAPL extraction wells for comparative and initial costing purposes.

Due to the more extensive extraction network, the analysis of alternatives and cost estimate for Alternative DAPL 2B assumes that 100% of the accessible DAPL present in the OPWD DAPL pool (1.3 million gallons) will be recovered and treated on-site.

## 1.3 Alternative DAPL 3: DAPL Extraction from Containment Area DAPL Pool: Section 3.2.2.3

Alternative DAPL 3 addresses the On-Property (Containment Area) DAPL Pool. It includes institutional controls for properties above the footprint of the DAPL pools to prevent groundwater use, installation of a DAPL extraction and treatment system, O&M, monitoring, and Five-Year Reviews.

For comparative and initial costing purposes, an estimated DAPL pool volume of 240,000 gallons was used (Geomega, 2020, Table 4). This estimate was based on the most recent (2019) sampling results.

Alternative DAPL 3 includes two alternatives to provide a range of extraction wells, one with minimal additional infrastructure (DAPL 3A) and one with increased DAPL removal efficiency (DAPL 3B) as described in the subsections below. The number of extraction wells described below are intended to provide a reasonable range for treatment. Additional wells may be required in the future based on PDI results and observations during remedy implementation.

### 1.3.1 Alternative DAPL 3A

Alternative DAPL 3A includes installation of a single, centrally located extraction well at the lowest point of the bedrock depression within the Containment Area. Current data indicate that the bedrock surface slopes gently beneath the DAPL area; therefore, sustainable gravity-driven extraction rates are expected to be like those of the OPWD Pool. If the bedrock surface is more complex (multiple low areas), the DAPL pool may not be fully captured by a single extraction well. Actual extraction rates and the extraction well location would be evaluated as part of the system design and O&M. Figure 3 depicts potential DAPL extraction wells for comparative and initial costing purposes.

The analysis of alternatives and cost estimate for Alternative DAPL 3A assumes that 95% of the accessible DAPL present in the Containment Area DAPL pool (228,000 gallons) will be recovered and treated on-site.

### 1.3.2 Alternative DAPL 3B

Alternative DAPL 3B includes the extraction well included in DAPL 3A plus one or more auxiliary extraction points to allow for relatively slow DAPL extraction at each point, provides flexibility with pumping rates, and targets any bedrock low spots identified during system design. Figure 3 depicts potential DAPL extraction wells for comparative and initial costing purposes.

Due to the more extensive extraction network, the analysis of alternatives and cost estimate for Alternative DAPL 3B assumes that 100% of the accessible DAPL present in the Containment Area DAPL pool (0.24 million gallons) will be recovered and treated on-site.

## 1.4 Alternative DAPL 4: DAPL Extraction from Main Street DAPL Pool: Section 3.2.2.4

Alternative DAPL 4 addresses the Main Street DAPL Pool. It includes institutional controls for properties above the footprint of the DAPL pool to prevent groundwater use, installation of a DAPL extraction and treatment system, O&M, monitoring, and Five-Year Reviews.

For comparative and initial costing purposes, an estimated DAPL pool volume of 13.3 million gallons was used (Geomega, 2020, Table 4). This estimate was based on the most recent (2019) sampling results.

Alternative DAPL 4 includes two alternatives to provide a range of extraction wells – one with minimal additional infrastructure (DAPL 4A) and one with increased DAPL removal efficiency (DAPL 4B), as described in the subsections below.

The number of extraction wells described below are intended to provide a reasonable range for treatment. Additional wells may be required in the future based on PDI results and observations during remedy implementation.

### 1.4.1 Alternative DAPL 4A

Alternative 4A includes three extraction wells at bedrock low points identified using available data and assumes that each extraction well could be pumped at 0.5 gpm based on the more steeply-dipping bedrock slopes at the Main Street DAPL pool. Actual extraction rates would be evaluated as part of the system design and O&M. Figure 4 depicts potential DAPL extraction wells for comparative and initial costing purposes.

The analysis of alternatives and cost estimate for Alternative DAPL 4A assumes that 95% of the accessible DAPL present in the Main Street DAPL pool (12.635 million gallons) will be recovered and treated on-site.

### 1.4.2 Alternative DAPL 4B

Alternative 4B includes a total of 12 extraction wells, each pumping at an average rate of 0.5 gpm to maintain an overall removal rate of 6 gpm and target bedrock variability in this much larger area. Figure 4 depicts potential DAPL extraction wells for comparative and initial costing purposes.

Due to the more extensive extraction network, the analysis of alternatives and cost estimate for Alternative DAPL 4B assumes that 100% of the accessible DAPL present in the Main Street DAPL pool (13.3 million gallons) will be recovered and treated on-site.

## 2.0 SCREENING OF ALTERNATIVES: SECTION 3.3.2

Alternative DAPL 1 is the no-further-action alternative that is required to be retained as a baseline comparison to the other alternatives. As described in the previous section, two active alternatives are described for each of the three DAPL pools (DAPL 2A/B, 3A/B, and 4A/B). All seven alternatives have been retained in the initial screening.

## 3.0 ANALYSIS OF ALTERNATIVES: SECTION 4.1 AND 4.3

The detailed analysis of alternatives follows EPA guidance (EPA, 1988) that includes the following evaluation criteria:

**Threshold Criteria:**

- **Overall Protection of Human Health and the Environment** – This criterion provides a final check to ensure that the alternative provides adequate protection of human health and the environment.
- **Compliance with ARARs** – This criterion describes how each alternative will comply with federal and state ARARs, or in cases where an ARAR will not be met, justifies waiver(s) available under CERCLA.

**Primary Balancing Criteria:**

- **Long-Term Effectiveness and Permanence** – This criterion evaluates the risks remaining after the remedial alternative has been enacted and the RAOs have been achieved. The primary focus of this evaluation is procedures or controls that manage risks associated with treatment residuals and/or untreated wastes. Specifically, the magnitude of residual risks and the adequacy and reliability of controls for each alternative are examined.
- **Reduction of Toxicity, Mobility, or Volume through Treatment** – This criterion addresses the statutory preference for selecting remedial alternatives that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances.
- **Short-Term Effectiveness** – This criterion evaluates the impacts to human health (on-site workers and community) and the environment during construction and implementation of the remedial alternatives. Sustainability aspects of the alternatives are also evaluated under this criterion.
- **Implementability** – This criterion evaluates the technical and administrative implementability of the remedial actions and the relative availability of services and materials. The evaluation of the technical implementability includes short-term difficulties in construction and operation, the reliability of the technology, the relative ease of undertaking additional remedial actions, and monitoring considerations. Administrative implementability considers the administrative requirements needed to perform the remedy (such as securing rights of way and permits). The evaluation of the

relative availability of services and materials determines the ease of which specialized services, materials, or equipment may be obtained.

- **Cost** – A detailed cost analysis is performed for each alternative to assess the net present worth cost to implement each alternative. The cost analyses include estimates of the capital costs and annual O&M costs for the alternative, and a present worth analysis using a discount rate of 7% (EPA, 2000).

**Modifying Criteria:** Modifying criteria include state and community acceptance. These will be addressed following the public comment period.

The detailed analysis for each alternative is provided in the following sections.

### 3.1 Alternative DAPL 1: No Further Action: Section 4.1

Alternative DAPL 1 is a no-further-action alternative. No additional work would be performed to address contamination from the three DAPL pools. Because contamination would be left on-site at concentrations above risk-based standards, Five-Year Reviews would be required.

#### 3.1.1 Overall Protection of Human Health and the Environment: Section 4.1.2

The following describes the overall protection of human health and the environment for Alternative DAPL 1:

<u>Protection of human health</u>: No further action would be taken, and there would be no reduction in risk. In addition, DAPL 1 does not include measures to prevent human exposure to DAPL containing Site contaminants of concern (COCs) in groundwater.

<u>Protection of the environment</u>: Would not be protective of the environment. DAPL would remain in the subsurface and would serve as a continuing source of extremely high contaminant concentrations to overlying groundwater, underlying bedrock, and potentially surface water.

#### 3.1.2 Compliance with ARARs: Section 4.1.3

The following describes Alternative DAPL 1's compliance with ARARs:

Chemical-specific ARARs: Not applicable; there are no chemical-specific ARARs because the RAOs for DAPL are not based on attainment of concentrations of specific ARARs.

Action-specific ARARs: Not applicable; there are no action-specific ARARs because no actions are proposed.

Location-specific ARARs: Not applicable; there are no location-specific ARARs because no actions are proposed that would affect protected resources.

### 3.1.3 Long-Term Effectiveness and Permanence: Section 4.1.5

The following describes the long-term effectiveness and permanence of DAPL 1:

Magnitude of residual risk: There would be no change in the magnitude of residual risk. DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: No additional actions or controls would be implemented to decrease contaminant concentrations or migration.

### 3.1.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.1.6

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 1:

Treatment process used and materials treated: This alternative does not include active treatment.

Amount of hazardous materials removed or treated: No material would be removed or treated. Natural processes are not expected to degrade or remove hazardous material over any reasonable timeframe.

Reduction of toxicity, mobility or volume through treatment: No active treatment would occur. Natural processes are not expected to reduce toxicity, mobility, or volume over any reasonable timeframe.

Degree to which the treatment is reversible: No treatment would be performed. Some natural attenuation of organics may occur over an extremely long time, and these would be irreversible. Precipitation of DAPL constituents may be reversible given changes in geochemistry.

Type and quantity of residuals remaining after treatment: No treatment would be performed. Any residuals from natural processes would remain.

Satisfies statutory preference for treatment: Does not satisfy statutory preference for treatment.

### 3.1.5 Short-Term Effectiveness: Section 4.1.4

The following describes the short-term effectiveness of Alternative DAPL 1:

Risks to the community during implementation of remedial action: There would be no remedial activities and no resulting risks to the community.

Risks to workers during implementation of remedial action: There would be no remedial activities and no resulting risks to workers.

Environmental impacts: Without any active remedial activities, there are no additional short-term impacts to the environment.

Sustainability: Without any active remedial activities, there are no sustainability concerns.

Time until RAOs are met: Without active remediation, the DAPL pools are expected to serve as major sources of contamination near-indefinitely (at least hundreds of years).

### 3.1.6 Implementability: Section 4.1.7

The following describes the implementability of Alternative DAPL 1:

Ability to construct and operate the technology: Alternative DAPL 1 is readily implementable, as no remedial actions are conducted. Five-year reviews are easily implemented.

Reliability of the technology: No technology will be used; therefore, reliability cannot be examined.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented.

Ability to monitor remedy effectiveness: Monitoring is not included in Alternative DAPL 1.

Ability to obtain approvals from other agencies: None required.

Coordination with other agencies: None required.

Availability of off-site treatment, storage and disposal facilities (TSDFs): None required.

Availability of necessary equipment and specialists: None required.

Availability of prospective technologies: None required.

#### 3.1.7 Costs: Section 4.1.8

Alternative DAPL 1 has no capital or maintenance costs.

### 3.2 Alternative DAPL 2A: DAPL Extraction in the OPWD DAPL Pool (1 extraction well): Section 4.3.2

Alternative DAPL 2A consists of institutional controls, DAPL extraction in the OPWD (Jewel Drive) DAPL pool via one extraction well, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

Institutional controls: A Notice of Activity and Use Limitation (NAUL) or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. These institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

DAPL extraction includes one replacement extraction well that would be pumped at 0.25 gpm. It would require approximately 12 years of operation (rounding up to the nearest half year) to address approximately 95% of the estimated 1.3 million gallons of DAPL (1.235 million gallons). See Attachment A-1. Figure 2 depicts potential DAPL extraction wells for both DAPL 2 alternatives. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 2A. Alternative DAPL 2A does not directly address DAPL in bedrock, but does address the source of potential future impacts to bedrock.

The new extraction well pump and conveyance system is planned to be similar to the current installation, including variable speed peristaltic-type pumps discharged through a heat-traced conveyance system comprised of a 1½-inch diameter high density polyethylene (HDPE) carrier pipe contained within a 4-inch diameter polyvinyl chloride (PVC) containment pipe.

When Olin installed the DAPL pilot system, a blank pipe sleeve was installed with the current DAPL transfer pipe. Depending on where new well(s) are installed, piping or DAPL will be routed through existing clean out vaults and conveyance lines or a new conveyance line will be installed. DAPL would be pumped to the current storage tank where it will be stored prior to on-site treatment.

Based on the results of long term DAPL extraction from the OPWD DAPL Pool and the DAPL density driven flow considerations discussed in Section 4.3.1.1, a DAPL extraction rate of 0.25 gpm was used for costing and DAPL removal timeframe calculations for Alternative DAPL 2A. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction with time as DAPL pool volume decreases. Residual DAPL may remain on the bedrock surface in isolated and localized low points within the DAPL pool.

O&M: Alternative DAPL 2A would require long-term O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction system performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction wells. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test. O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.
- Pump maintenance and periodic replacement, as needed.
- Periodic tubing replacement.
- DAPL treatment system O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

<u>Monitoring</u>: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.
- Assess trends of monitored parameters in DAPL and groundwater.
- Assess specific chemical characteristics of the extracted DAPL.

Olin currently uses two multilevel piezometers (ML-1 and ML-2) and two induction logging wells (ILW-1 and ILW-2) to monitor progress of DAPL removal at EW-1. Olin uses a third multilevel piezometer (MP-2) farther from the extraction well to monitor DAPL elevation. After EW-1 is replaced, consideration will be given to installing a multilevel device in EW-1 or installing additional multilevel piezometers at appropriate locations.

It is assumed that performance monitoring will be conducted monthly to bi-monthly during system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; ultraviolet (UV) photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 1,376 tons of sludge and soils residuals generated from DAPL treatment (Table 1) would be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.2.1 Overall Protection of Human Health and the Environment: Section 4.3.2.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 2A:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and downgradient (by reducing the mass available to migrate away from the DAPL pool). In addition, DAPL 2A's institutional controls would prevent human exposure to DAPL containing Site COCs.

Protection of the environment: Removal of the DAPL would reduce the potential for migration of contamination into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.2.2 Compliance with ARARs: Section 4.3.2.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 2A is provided in Table 2. The ARAR analysis is the same for DAPL 2A and DAPL 2B, since they differ only in the number and configuration of extraction wells. The following describes Alternative DAPL 2A's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 2A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 2B for details.

### 3.2.3 Long-Term Effectiveness and Permanence: Section 4.3.2.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 2A:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced to the extent that residual DAPL could be effectively targeted. Remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk.

This alternative does not include DAPL extraction beneath the building at the expected bedrock low spot and is expected to have a lower overall effectiveness in capturing as much residual DAPL as possible.

### 3.2.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.2.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 2A:

Treatment process used and materials treated: DAPL will be treated on-site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 2A would remove an estimated 1.235 million gallons of DAPL for on-site treatment. This estimate will be refined based on investigations to better define the bedrock topography in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, trace levels of DAPL precipitate remaining in the subsurface may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 1,376 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.2.5 Short-Term Effectiveness: Section 4.3.2.2.3

The following describes the short-term effectiveness of Alternative DAPL 2A:

Risks to the community during implementation of remedial action: Installation of extraction and monitoring wells would involve minimal risk to the community and would follow best management practices (BMPs) to alleviate community concerns. DAPL would be piped from the extraction points to a collection tank on the Olin property. Off-property piping is expected to be routed underground. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. Environmental risks during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 2A would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resource to conduct system O&M.

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the OPWD DAPL pool. DAPL removal (95% effectiveness for accessible DAPL) is anticipated to be completed within 12 years of system construction.

### 3.2.6 Implementability: Section 4.3.2.2.6

The following describes the implementability of Alternative DAPL 2A:

Ability to construct and operate the technology: Alternative DAPL 2A would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. The replacement well for current extraction well EW-1 does not have implementability issues. Treatability studies will be required to determine the treatment train, technologies, and materials required to effectively treat the extracted DAPL. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented, although the presence of additional boreholes may complicate some future remedial actions.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, similar to the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals will be disposed of off-site as non-hazardous waste.

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to extract, transport, and store DAPL prior to treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

#### 3.2.7 Costs: Section 4.3.2.2.7

Costs for Alternative DAPL 2A are provided in Attachment A-1. The total cost is estimated to be $2,220,000 and the present value is $1,656,000. These costs are based on a DAPL volume of 1.235 million gallons and one extraction well.

### 3.3 Alternative DAPL 2B: DAPL Extraction in the OPWD DAPL Pool (up to 4 extraction wells): Section 4.3.2

Alternative DAPL 2B consists of institutional controls, DAPL extraction in the OPWD (Jewel Drive) DAPL pool via four extraction wells, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

Institutional controls: A NAUL or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. The institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

DAPL extraction includes new extraction wells that would be pumped at 0.25 gpm each. It would require approximately 3.5 years of operation (rounding up to the nearest half year) to address an estimated 1.3 million gallons of DAPL (see Attachment A-2). Alternative DAPL 2B does not directly address DAPL in bedrock, but it does address the source of potential future impacts to bedrock.

Borings will be installed to bedrock to confirm bedrock elevations and geophysical data. The current extraction well may be converted to a multilevel well or replaced with a new multi-level well. Four new extraction wells are proposed for costing and comparative purposes; however, additional extraction wells may be added based on PDI results and/or observations during remedy implementation. Multiple DAPL extraction wells may be required to minimize drawdown, provide flexibility with pumping rates, and target bedrock low spots identified during system design. Figure 2 depicts potential DAPL extraction wells. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 2B.

The new extraction well pump and conveyance systems are planned to be like the current installation, including variable speed peristaltic-type pumps discharged through a heat-traced conveyance system comprised of a 1½-inch diameter HDPE carrier pipe contained within a 4-inch diameter PVC containment pipe. When Olin installed the DAPL pilot system, a blank pipe sleeve was installed with the current DAPL transfer pipe. Depending on where new well(s) are installed, piping or DAPL will be routed through existing clean out vaults and conveyance lines or a new conveyance line will be installed. DAPL would be pumped to the current storage tank where it will be stored prior to on-site treatment. For costing purposes, additional pipe runs were assumed to extend to the existing storage tank.

Based on the results of long term DAPL extraction from the OPWD DAPL Pool and the DAPL density driven flow considerations discussed in Section 4.3.1.1, a combined DAPL extraction rate of 1 gpm (0.25 gpm for each of the four wells) for costing and DAPL removal timeframe calculations was used. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction with time as DAPL pool volume decreases.

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O&M: Alternative DAPL 2B would require long-term O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M and monitoring is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction system performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction wells. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test. O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.
- Pump maintenance and periodic replacement, as needed.
- Periodic tubing replacement.
- DAPL treatment system O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

Monitoring: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.
- Assess trends of monitored parameters in DAPL and groundwater.
- Assess specific chemical characteristics of the extracted DAPL.

Olin currently uses two multilevel piezometers (ML-1 and ML-2) and two induction logging wells (ILW-1 and ILW-2) to monitor progress of DAPL removal at EW-1. Olin uses a third multilevel piezometer (MP-2) farther from the extraction well to monitor DAPL elevation. After EW-1 is replaced, consideration will be given to installing a multilevel device in EW-1 or installing an additional multilevel piezometer at an appropriate location.

It is assumed that performance monitoring will be conducted monthly to bi-monthly during the system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; UV photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 1,448 tons of sludge and soils residuals generated from DAPL treatment will be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.3.1 Overall Protection of Human Health and the Environment: Section 4.3.2.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 2B:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and downgradient (by reducing the mass available to migrate away from the DAPL pool). In addition, DAPL 2B's institutional controls would prevent human exposure to DAPL containing Site contaminants in groundwater.

Protection of the environment: Removal of the DAPL would reduce the potential for migration of contamination into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.3.2 Compliance with ARARs: Section 4.3.2.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 2B is provided in Table 2. The ARAR analysis is the same for DAPL 2A and DAPL 2B, as these differ only in the number and configuration of extraction wells. The following describes Alternative DAPL 2B's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 2A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 2B for details.

### 3.3.3 Long-Term Effectiveness and Permanence: Section 4.3.2.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 2B:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced. Any remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk.

This alternative combines more extraction wells and at least one location beneath the building, allowing for flexibility and targeting of the expected bedrock low spot to capture as much residual DAPL as possible.

### 3.3.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.2.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 2B:

Treatment process used and materials treated: DAPL will be treated on site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 2B would remove an estimated 1.3 million gallons of DAPL for off-site disposal. This estimate will be refined based on investigations to better define the bedrock topography in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, trace levels of DAPL precipitate remaining in the subsurface may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 1,448 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.3.5 Short-Term Effectiveness: Section 4.3.2.2.3

The following describes the short-term effectiveness of Alternative DAPL 2B:

Risks to the community during implementation of remedial action: Installation of extraction and monitoring wells would involve minimal risk to the community and would follow best BMPs to alleviate community concerns. DAPL would be piped from the extraction points to a collection tank on the Olin property. Off-property piping is expected to be routed underground. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. Environmental risks during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 2B would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resource to conduct system O&M; however, these impacts would be of short duration (estimated to be less than 4 years).

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the OPWD DAPL pool. DAPL removal is anticipated to be completed after an estimated 3 years of system construction.

### 3.3.6 Implementability: Section 4.3.2.2.6

The following describes the implementability of Alternative DAPL 2B:

Ability to construct and operate the technology: Alternative DAPL 2B would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. Installation of additional extraction and monitoring wells may be more difficult to implement because of constraints due to existing building structures, but other technologies exist (such as angled boreholes) to complete construction. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented, although the presence of additional boreholes may complicate some future remedial actions.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, similar to the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals are expected to be disposed of off-site as non-hazardous waste

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to extract, transport, and store DAPL prior to treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

### 3.3.7 Costs: Section 4.3.2.2.7

Costs for Alternative DAPL 2B are provided in Attachment A-2. The total cost is estimated to be $2,399,000 and the present value is $2,215,000. These costs are based on a DAPL volume of 1.3 million gallons and four extraction wells.

## 3.4 Alternative DAPL 3A: DAPL Extraction in the Containment Area DAPL Pool (1 extraction well): Section 4.3.3

Alternative DAPL 3A consists of institutional controls, DAPL extraction in the on-property (Containment Area) DAPL pool via one extraction well, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

Institutional controls: A NAUL or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. These institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

DAPL extraction: A DAPL extraction system like that of the OPWD DAPL pool would be installed at the Containment Area DAPL pool. Alternative DAPL 3A does not directly address DAPL in bedrock, but it does address the source of potential future impacts to bedrock.

The extraction well would be constructed similarly to EW-1, except with a 2-foot screen length. Based on soil borings and excavation during the slurry wall installation at the Containment Area, the bottom of the till has numerous boulders; therefore, vertical well construction is considered the most appropriate method for this area. Vertical wells provide more dependable and predictable contact because the screen is designed to intercept the target material. Vertical wells also provide more certainty regarding the elevation and strata that are the focus of the extraction and allow for extraction from the system's lowest point and are less likely to be hindered by boulders during well installation (as compared to angled boreholes or directional drilling).

Induction logging wells and multi-port piezometers would be constructed in the same manner as existing monitoring points in the OPWD DAPL pool. Extraction pump(s) will be a variable speed peristaltic-type to protect pump mechanics from contact with DAPL. The pump rotation speed and discharge would be regulated by a variable frequency drive set and monitored by the control panel located adjacent to the DAPL storage tank at the Olin Property. The discharge pipe would be an equivalent design as installed at the OPWD pool. Figure 3 depicts potential DAPL extraction wells. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 3A. See Attachment A-3.

Based on the results of long term DAPL extraction from the OPWD DAPL Pool and the DAPL density driven flow considerations discussed in Section 4.3.1.1, a DAPL extraction rate of 0.25

gpm is assumed for costing and DAPL removal timeframe calculations. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction as DAPL pool volume decreases. Residual DAPL may remain on the bedrock surface in isolated and localized low points within the DAPL pool.

O&M: Alternative DAPL 3A would require O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M and monitoring is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction well. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test.
O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.
- Pump maintenance and periodic replacement, as needed.
- Periodic tubing replacement.
- DAPL treatment system O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

Monitoring: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.
- Assess trends of monitored parameters in DAPL and groundwater.

- Assess specific chemical characteristics of the extracted DAPL.

Paired multilevel piezometers and induction logging wells will be installed for the extraction well to monitor DAPL drawdown and groundwater characteristics. It is assumed that performance monitoring will be conducted monthly to bi-monthly during system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; UV photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 254 tons of sludge and soils residuals generated from DAPL treatment will be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.4.1 Overall Protection of Human Health and the Environment: Section 4.3.3.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 3A:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and reduce the potential for DAPL to escape the Containment Area. In addition, DAPL 3A's institutional controls would prevent human exposure to DAPL containing Site contaminants in groundwater.

Protection of the environment: Removal of the DAPL would further reduce the potential for migration of contamination beneath or through the slurry wall, or into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.4.2 Compliance with ARARs: Section 4.3.3.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 3A is provided in Table 3. The ARAR analysis is the same for DAPL 3A and DAPL 3B, which differ only in the number of extraction wells. The following describes Alternative DAPL 3A's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 3A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 3B for details.

### 3.4.3 Long-Term Effectiveness and Permanence: Section 4.3.3.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 3A:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced to the extent that residual DAPL could be effectively targeted. Remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk. This alternative has only one extraction well and is expected to have a lower overall effectiveness than Alternative DAPL 3B in capturing as much residual DAPL as possible.

### 3.4.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.3.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 3A:

Treatment process used and materials treated: DAPL will be treated on-site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 3A would remove an estimated 228,000 gallons of DAPL for on-site treatment. This estimate will be refined based on investigations to better define the bedrock topography in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, trace levels of DAPL precipitate remaining in the subsurface may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 254 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.4.5 Short-Term Effectiveness: Section 4.3.3.2.3

The following describes the short-term effectiveness of Alternative DAPL 3A:

Risks to the community during implementation of remedial action: All work would be performed within the Olin property boundary. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. Environmental risks during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 3A would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resource to conduct system O&M; however, these impacts would be of short duration (estimated to be approximately 2 years).

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the Containment Area DAPL pool. DAPL removal (95% effectiveness for accessible DAPL) is anticipated to be completed within 3 years of system construction.

### 3.4.6 Implementability: Section 4.3.3.2.6

The following describes the implementability of Alternative DAPL 3A:

Ability to construct and operate the technology: Alternative DAPL 3A would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. There are no significant barriers or complications for installation of extraction wells and piping. Treatability studies will be required to determine the treatment train, technologies, and materials required to effectively treat the extracted DAPL. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, as was done during the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals are expected to be disposed of off-site as non-hazardous waste.

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to transport and store DAPL prior treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract and treat DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

#### 3.4.7 Costs: Section 4.3.3.2.7

Costs for Alternative DAPL 3A are provided in Attachment A-3. The total cost is estimated to be $983,000 and the present value is $925,000, based on a DAPL volume of 228,000 gallons.

### 3.5 Alternative DAPL 3B: DAPL Extraction in the Containment Area DAPL Pool (up to 4 extraction wells): Section 4.3.3

Alternative DAPL 3B consists of institutional controls, DAPL extraction in the on-property (Containment Area) DAPL pool via 3 extraction wells, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

Institutional controls: A NAUL or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. These institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

DAPL extraction: A DAPL extraction system like that of the OPWD DAPL pool would be installed at the Containment Area DAPL pool. Alternative DAPL 3B does not directly address DAPL in bedrock, but it does address the source of potential future impacts to bedrock.

Extraction well(s) would be constructed similarly to EW-1, except with a 2-foot screen length. Based on soil borings and excavation during the slurry wall installation at the Containment Area, the bottom of the till has numerous boulders; therefore, vertical well construction is considered the most appropriate method for this area. Vertical wells provide more dependable and predictable contact because the screen is designed to intercept the target material. Vertical wells also provide more certainty regarding the elevation and strata that are the focus of the extraction and allow for extraction from the system's lowest point and are less likely to be hindered by boulders during well installation(as compared to angled boreholes or directional drilling). Extraction well locations will be determined based on PDI results.

Induction logging wells and multi-port piezometers would be constructed in the same manner as existing monitoring points in the OPWD DAPL pool. Extraction pumps will be a variable speed peristaltic-type to protect pump mechanics from contact with DAPL. The pump rotation speed and discharge would be regulated by a variable frequency drive set and monitored by the control panel located adjacent to the DAPL storage tank at the Olin Property. The discharge pipe would be an equivalent design as installed at the OPWD pool.

For planning and comparison purposes, four extraction points are planned to intercept bedrock low spots, provide flexibility with pumping rates, and minimize drawdown at any one point. The number and configuration of extraction wells will be determined based on investigations conducted for remedy design, and additional extraction wells may be added based on PDI results and/or observations during remedy implementation. Figure 3 depicts potential DAPL extraction wells. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 3B (see Attachment A-4).

Based on the results of long term DAPL extraction from the OPWD DAPL Pool and the DAPL density driven flow considerations discussed in Section 4.3.1.1, a combined DAPL extraction rate of 1 gpm (0.25 gpm for each of the four wells) is assumed for costing and DAPL removal timeframe calculations. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction as DAPL pool volume decreases.

O&M: Alternative DAPL 3B would require O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M and monitoring is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction system performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction wells. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test.
O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.
- Pump maintenance and periodic replacement, as needed.
- Periodic tubing replacement.
- DAPL treatment system O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

Monitoring: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.

- Assess trends of monitored parameters in DAPL and groundwater.
- Assess specific chemical characteristics of the extracted DAPL.

Paired multilevel piezometers and induction logging wells will be installed for each extraction well to monitor DAPL drawdown and groundwater characteristics. It is assumed that performance monitoring will be conducted monthly to bi-monthly during system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; UV photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 267 tons of sludge and soils residuals generated from DAPL treatment will be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.5.1 Overall Protection of Human Health and the Environment: Section 4.3.3.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 3B:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and reduce the potential for DAPL to escape the Containment Area. In addition, DAPL 3B's institutional controls would prevent human exposure to DAPL containing Site contaminants in groundwater.

Protection of the environment: Removal of the DAPL would further reduce the potential for migration of contamination beneath or through the slurry wall, or into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.5.2 Compliance with ARARs: Section 4.3.3.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 3B is provided in Table 3. The ARAR analysis is the same for DAPL 3A and DAPL 3B, which differ only in the number of extraction wells. The following describes Alternative DAPL 3B's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 3A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 3B for details.

### 3.5.3 Long-Term Effectiveness and Permanence: Section 4.3.3.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 3B:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced. Any remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk. This alternative installs more extraction wells, allowing for additional flexibility and targeting of bedrock low spots and isolated basins to capture as much residual DAPL as possible.

### 3.5.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.3.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 3B:

Treatment process used and materials treated: DAPL will be treated on-site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 3B would remove an estimated 240,000 gallons of DAPL for on-site treatment. This estimate will be refined based on investigations to better define the bedrock topography in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, any anions and cations remaining in the subsurface as a precipitate may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 267 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.5.5 Short-Term Effectiveness: Section 4.3.3.2.3

The following describes the short-term effectiveness of Alternative DAPL 3B:

Risks to the community during implementation of remedial action: All work would be performed within the Olin property boundary. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. Environmental risks during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 3B would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resource to conduct system O&M; however, these impacts would be of short duration (estimated to be less than 1 year).

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the Containment Area DAPL pool. DAPL removal is anticipated to be completed within 1 year of system construction.

### 3.5.6 Implementability: Section 4.3.3.2.6

The following describes the implementability of Alternative DAPL 3B:

Ability to construct and operate the technology: Alternative DAPL 3B would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. There are no significant barriers or complications for installation of extraction wells and piping. Treatability studies will be required to determine the treatment train, technologies, and materials required to effectively treat the extracted DAPL. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, as done during the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals are expected to be disposed of off-site as non-hazardous waste.

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to transport and store DAPL prior to treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

### 3.5.7 Costs: Section 4.3.3.2.7

Costs for Alternative DAPL 3B are provided in Attachment A-4. The total cost is estimated to be $1,614,000 and the present value is $1,564,000. These costs are based on a DAPL volume of 240,000 gallons and up to four extraction wells.

### 3.6 Alternative DAPL 4A: DAPL Extraction in the Main Street DAPL Pool (3 extraction wells): Section 4.3.4

Alternative DAPL 4A consists of institutional controls, DAPL extraction in the Main Street DAPL pool via three extraction wells, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

Institutional controls: A NAUL or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. These institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

DAPL extraction: A DAPL extraction system similar to that of the OPWD DAPL pool would be installed at the Main Street DAPL pool. Multiple extraction wells would be used to target bedrock low points and to provide adequate coverage across the entire DAPL pool area. Alternative DAPL 4A does not directly address DAPL in bedrock, but it does address the source of potential future impacts to bedrock.

Extraction wells would be constructed similarly to EW-1, except with a 2-foot screen length. Induction logging wells and multi-port piezometers would be associated with each extraction well and constructed in the same manner as existing monitoring points in the OPWD DAPL pool.

The nature of the localized depressions that will be targeted for extraction well installations are accessible by vertical well locations and therefore directional drilling offers no advantages. The steeper slopes associated with the Main Street DAPL pool should allow for higher sustainable extraction rates than the DAPL Extraction Pilot Test's rate of less than 0.5 gpm.

For planning and comparison purposes, 3 extraction points are planned to intercept bedrock low spots. Figure 4 depicts potential DAPL extraction wells. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 4A. See Attachment A-5 for details.

Alternative DAPL 4A relies on a sustainable pumping rate of 0.5 gpm based on the deeper bedrock and steeper sides of the Main Street DAPL pool. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction with time as DAPL pool volumes diminish. Residual DAPL may remain on the bedrock surface in isolated and localized low points within the DAPL pool. For the purpose of comparing alternatives, it is assumed that 5% of the accessible DAPL volume would not be captured by the extraction system.

Extraction pump(s) will be a variable speed peristaltic-type to protect pump mechanics from contact with DAPL. The pump rotation speed and discharge would be regulated by a variable frequency drive set and monitored by the control panel located adjacent to the DAPL storage tank at the Olin Property. The discharge pipe would be an equivalent design as installed at the OPWD pool.

O&M: Alternative DAPL 4A would require O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction wells. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test. O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.
- Pump maintenance and periodic replacement as needed.
- Periodic tubing replacement.
- DAPL treatment O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

Monitoring: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.
- Assess trends of monitored parameters in DAPL and groundwater.
- Assess specific chemical characteristics of the extracted DAPL.

Paired multilevel piezometers and induction logging wells will be installed for each extraction well to monitor DAPL drawdown and groundwater characteristics. It is assumed that performance monitoring will be conducted monthly to bi-monthly during system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; UV photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 14,075 tons of sludge and soils residuals generated from DAPL treatment will be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.6.1 Overall Protection of Human Health and the Environment: Section 4.3.4.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 4A:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and downgradient (by reducing the mass available to migrate away from the DAPL pool). In addition, DAPL 4A's institutional controls would prevent human exposure to DAPL containing Site contaminants in groundwater.

Protection of the environment: Removal of the DAPL would reduce the potential for migration of contamination into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.6.2 Compliance with ARARs: Section 4.3.4.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 4A is provided in Table 4. The ARAR analysis is the same for DAPL 4A and DAPL 4B, as these differ only in the number of extraction wells and the extraction rate. The following describes DAPL 4A's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 4A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 4B for details.

### 3.6.3 Long-Term Effectiveness and Permanence: Section 4.3.4.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 4A:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced to the extent that residual DAPL could be effectively targeted. Remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk. However, this alternative has a minimal number of extraction wells (3) for a large area and is expected to have a lower overall effectiveness in capturing as much residual DAPL as possible.

### 3.6.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.4.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 4A:

Treatment process used and materials treated: DAPL will be treated on-site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 4A would remove an estimated 12.635 million gallons of DAPL for on-site treatment. This estimate will be refined based on investigations to better define the bedrock topography and elevation of the top of DAPL in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, trace levels of DAPL precipitate remaining in the subsurface may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 14,075 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.6.5 Short-Term Effectiveness: Section 4.3.4.2.3

The following describes the short-term effectiveness of Alternative DAPL 4A:

Risks to the community during implementation of remedial action: Installation of extraction and monitoring wells would involve minimal risk to the community and would follow BMPs to alleviate community concerns. DAPL would be piped from the extraction points to a collection tank on the Olin property. Off-property piping is expected to be routed underground. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. DAPL risks to the environment during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 4A would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resources to conduct system O&M. These impacts would be the longest duration of the active remedy components (20 years).

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the Main Street DAPL pool. DAPL removal (95% effectiveness for accessible DAPL) is anticipated to be completed 20 years after system construction.

### 3.6.6 Implementability: Section 4.3.4.2.6

The following describes the implementability of Alternative DAPL 4A:

Ability to construct and operate the technology: Alternative DAPL 4A would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. Alternative 4A would require some coordination and approvals with off-property landowners to allow for installation of site infrastructure including extraction and monitoring points and piping. There are no significant technical barriers or complications for installation of extraction wells and piping. Treatability studies will be required to determine the treatment train, technologies, and materials required to effectively treat the extracted DAPL. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, like the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals are expected to be disposed of off-site as non-hazardous waste

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to transport and store DAPL prior to treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

### 3.6.7 Costs: Section 4.3.4.2.7

Costs for Alternative DAPL 4A are provided in Attachment A-5. The total cost is estimated to be $19,824,000 and the present value is $11,232,000. These costs are based on a DAPL volume of 12.635 million gallons and three extraction wells.

## 3.7 Alternative DAPL 4B: DAPL Extraction in the Main Street DAPL Pool (12 extraction wells): Section 4.3.4

Alternative DAPL 4B consists of institutional controls, DAPL extraction in the Main Street DAPL pool, on-site treatment, off-site disposal of treatment residuals, O&M, monitoring, and 5-year reviews.

<u>Institutional controls</u>: A NAUL or other institutional controls (such as Town ordinances) will be installed for properties above the footprint of the DAPL pool. These institutional controls will limit the depth of ground disturbance and prohibit installation of wells other than those used for groundwater monitoring and other remedy components.

<u>DAPL extraction</u>: A DAPL extraction system similar to that of the OPWD DAPL pool would be installed at the Main Street DAPL pool. Multiple extraction wells would be used to target bedrock low points and for full coverage across the entire DAPL pool area. Alternative DAPL 4B does not directly address DAPL in bedrock, but it does address the source of potential future impacts to bedrock.

Extraction wells would be constructed similarly to EW-1, except with a 2-foot screen length. Induction logging wells and multi-port piezometers would be associated with each extraction well and constructed in the same manner as existing monitoring points in the OPWD DAPL pool. The nature of the localized depressions that will be targeted for extraction well installations are accessible by vertical well locations and therefore directional drilling offers no advantages. The steeper slopes associated with the Main Street DAPL pool should allow for higher sustainable extraction rates than the DAPL Extraction Pilot Test's rate of less than 0.5 gpm.

Extraction pump(s) will be a variable speed peristaltic-type to protect pump mechanics from contact with DAPL. The pump rotation speed and discharge would be regulated by a variable frequency drive set and monitored by the control panel located adjacent to the DAPL storage tank at the Olin Property. The discharge pipe would be an equivalent design as installed at the OPWD pool.

For planning and comparison purposes, twelve extraction points are planned to intercept bedrock low spots, provide flexibility with pumping rates, and minimize drawdown at any one point. The number and configuration of extraction wells will be determined based on investigations conducted for remedy design, and additional extraction wells may be added based on PDI results and/or observations during remedy implementation. Figure 4 depicts potential DAPL extraction wells. Table 1 summarizes the estimated DAPL volume, pumping rates, and extraction duration for Alternative DAPL 4B. See Attachment A-6 for details.

Based on the results of long term DAPL extraction from the OPWD DAPL Pool and the DAPL density driven flow considerations discussed in Section 4.3.1.1, a combined DAPL extraction rate of 6 gpm (0.5 gpm for each of the twelve wells) was assumed for costing and DAPL removal timeframe calculations. As DAPL levels drop, it may become necessary to progressively reduce the rate of DAPL extraction with time as DAPL pool volumes diminish.

<u>O&M</u>: Alternative DAPL 4B would require O&M to keep the extraction and treatment systems functioning properly and effectively. The scope of the proposed extraction system O&M is based on the Interim Response Steps Work Plan (MACTEC, 2008), Operations, Maintenance, and Performance Monitoring Plan (AMEC, 2012), and DAPL Extraction Pilot Study Performance Evaluation Report (AMEC, 2014). Treatment system O&M requirements would be developed during remedy design.

DAPL extraction system performance monitoring is assumed to occur monthly and consist of multi-level piezometer sampling and induction logging from the monitoring points installed in conjunction with the extraction wells. DAPL treatment system performance monitoring schedules would be evaluated as part of the remedy design.

Annual O&M cost assumptions were based on the O&M costs during the DAPL Pilot Test. O&M is assumed to include:

- Routine inspections of the extraction system components, including pumps, pump enclosure vaults, system controls and communication equipment, piping, storage tank(s), and tanker truck loading station(s).
- Periodic evaluation and adjustment of pumping rates.

- Pump maintenance and periodic replacement, as needed.
- Periodic tubing replacement.
- DAPL treatment O&M.
- Quarterly O&M inspections.
- Monitoring to confirm institutional control compliance.

Monitoring: System performance monitoring will be performed to:

- Evaluate the response of the DAPL and overlying groundwater during pumping.
- Assess trends of monitored parameters in DAPL and groundwater.
- Assess specific chemical characteristics of the extracted DAPL.

Paired multilevel piezometers and induction logging wells will be installed for each extraction well to monitor DAPL drawdown and groundwater characteristics. It is assumed that performance monitoring will be conducted monthly to bi-monthly during system operation and that operating conditions and monitoring data will be reported semi-annually.

On-site DAPL Treatment: Extracted DAPL will be treated on-site. The DAPL treatment train consists of lime precipitation of metals and dewatering/disposal of sludge; stripping of VOCs and ammonia; UV photooxidation of NDMA; and evaporation of remaining water and off-site disposal of the resulting residual solids. Additional details regarding the treatment train are included in Attachment B.

Off-site disposal: An estimated 14,816 tons of sludge and soils residuals generated from DAPL treatment will be transported off-site for disposal. This material is assumed to be non-hazardous waste.

5-Year reviews: CERCLA requires that any remedial action resulting in contaminants remaining on-site at concentrations above those allowing unlimited exposure and unrestricted use must be reviewed at least every five years. 5-Year reviews would be performed in accordance with Comprehensive Five-Year Review Guidance (EPA, 2001).

### 3.7.1 Overall Protection of Human Health and the Environment: Section 4.3.4.2.1

The following describes the overall protection of human health and the environment for Alternative DAPL 4B:

Protection of human health: Removal of the DAPL and its associated COCs would reduce the potential for human exposure in the immediate vicinity of the DAPL pool and downgradient (by reducing the mass available to migrate away from the DAPL pool). In addition, DAPL 4B's institutional controls would prevent human exposure to DAPL containing Site contaminants in groundwater.

Protection of the environment: Removal of the DAPL would reduce the potential for migration of contamination into overlying groundwater, underlying bedrock, and potentially surface water.

### 3.7.2 Compliance with ARARs: Section 4.3.4.2.2

A detailed evaluation of ARAR compliance for Alternative DAPL 4B is provided in Table 4. The ARAR analysis is the same for DAPL 4A and DAPL 4B, which differ only in the number of extraction wells and the extraction rate. The following describes DAPL 4B's compliance with ARARs:

Chemical-specific ARARs: DAPL extraction and treatment is an interim step that is not based on attainment of concentrations of specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. DAPL has been defined as having specific gravity greater than 1.025; other parameters including metals, anions, and geochemistry are also indicative of DAPL. This definition will be re-evaluated as part of the remedy design.

Action-specific ARARs: Work will comply with action-specific ARARs. See Table 4A for details.

Location-specific ARARs: Work in areas with location-specific ARARs will be performed in accordance with those ARARs. See Table 4B for details.

### 3.7.3 Long-Term Effectiveness and Permanence: Section 4.3.4.2.4

The following describes the long-term effectiveness and permanence of Alternative DAPL 4B:

Magnitude of residual risk: The magnitude of residual risk would be reduced with the removal of DAPL. Residual risk would be reduced. Any remaining DAPL may migrate via bedrock fractures and serve as a source of contamination to both overburden and bedrock groundwater via diffusion.

Adequacy and reliability of controls: Once removed, the DAPL would not pose further risk to potential future receptors or the environment. This would represent a permanent reduction in risk. This alternative combines a larger number of extraction wells, allowing for significant flexibility and targeting of bedrock low spots and isolated basins to capture as much residual DAPL as possible.

### 3.7.4 Reduction in Toxicity, Mobility, and Volume Through Treatment: Section 4.3.4.2.5

The following describes the reduction in toxicity, mobility, and volume of contaminants by Alternative DAPL 4B:

Treatment process used and materials treated: DAPL will be treated on-site. Details of the proposed treatment train are included in Attachment B.

Amount of hazardous materials removed or treated: Alternative DAPL 4B would remove an estimated 13.3 million gallons of DAPL for on-site treatment. This estimate will be refined based on investigations to better define the bedrock topography and elevation of the top of DAPL in the area.

Reduction of toxicity, mobility or volume through treatment: DAPL would be removed from the subsurface and treated on-site, thereby removing a major source for migration of contaminants in groundwater. Details of the proposed treatment train are included in Attachment B.

Degree to which the treatment is reversible: Removal of DAPL from the subsurface is irreversible. Only liquid would be removed; therefore, trace levels of DAPL precipitate remaining in the subsurface may be remobilized in the future if the aquifer geochemistry changes. DAPL treatment is irreversible.

Type and quantity of residuals remaining after treatment: Treatment residuals, sludge (metals precipitates) and evaporated solids, will be created from the treatment process. The residuals are expected to be non-hazardous. Approximately 14,816 tons of solids residuals will require off-site disposal. In addition, DAPL precipitates and isolated residual DAPL would remain in the subsurface after the readily extractable liquid is removed.

Satisfies statutory preference for treatment: DAPL extraction and on-site treatment does satisfy the statutory preference for treatment.

### 3.7.5 Short-Term Effectiveness: Section 4.3.4.2.3

The following describes the short-term effectiveness of Alternative DAPL 4B:

Risks to the community during implementation of remedial action: Installation of extraction and monitoring wells would involve minimal risk to the community and would follow BMPs to alleviate community concerns. DAPL would be piped from the extraction points to a collection tank on the Olin property. Off-property piping is expected to be routed underground. Risks from DAPL treatment and off-site disposal of residual solids are expected to be low. Overall risk to the community is low.

Risks to workers during implementation of remedial action: Installation of extraction and monitoring wells would involve standard construction risks. Risks during extraction and treatment system O&M would be minimal and would be addressed using BMPs.

Environmental impacts: BMPs during construction and system operation would minimize the likelihood and severity of any DAPL releases. The system would use existing pipelines to the extent practicable, minimizing environmental impacts. DAPL risks to the environment during transportation for off-site disposal of treatment residuals are relatively low.

Sustainability: Alternative DAPL 4B would require moderate resources to treat the DAPL on-site and to transport and dispose of treatment residuals off-site, and some resource to conduct system O&M; however, these impacts would be of short duration (estimated to be less than 6 years).

Time until RAOs are met: Potential for human exposure would be addressed once institutional controls are in place for the Main Street DAPL pool. DAPL removal is anticipated to be completed within 6 years of system construction.

### 3.7.6 Implementability: Section 4.3.4.2.6

The following describes the implementability of Alternative DAPL 4B:

Ability to construct and operate the technology: Alternative DAPL 4B would use similar technologies that have already been shown to be effective for the OPWD DAPL pool. Alternative 4B would require some coordination and approvals with off-property landowners to allow for installation of site infrastructure including extraction and monitoring points and piping, particularly given the large number of wells and other infrastructure associated with this alternative. There are no significant technical barriers or complications for installation of extraction wells and piping. Treatability studies will be required to determine the treatment train, technologies, and materials required to effectively treat the extracted DAPL. Five-year reviews and institutional controls are readily implemented.

Reliability of the technology: Based on the OPWD pilot test, the DAPL extraction is expected to be reliable. On-site treatment should undergo a bench-scale and/or pilot test prior to full-scale implementation.

Ease of implementing additional remedial actions: Future remedial actions could be readily implemented.

Ability to monitor remedy effectiveness: DAPL recovery and DAPL pool response would be effectively monitored with nearby monitoring points, like the OPWD pilot test.

Ability to obtain approvals from other agencies: No barriers to other agency approvals have been identified.

Coordination with other agencies: No issues have been identified with respect to coordination with other agencies.

Availability of off-site TSDFs: The DAPL will be treated on-site and treatment residuals (sludge/solid) will require disposal at an off-site TSDF. The treatment residuals are expected to be disposed of off-site as non-hazardous waste.

Availability of necessary equipment and specialists: DAPL extraction uses readily available remedial technology. Some infrastructure is already in place to transport and store DAPL prior to treatment. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

Availability of prospective technologies: Technologies to extract DAPL are readily available. Bench-scale and/or pilot testing will be conducted during the design phase to assess the DAPL treatment train proposed in Attachment B.

### 3.7.7 Costs: Section 4.3.4.2.7

Costs for Alternative DAPL 4B are provided in Attachment A-6. The total cost is estimated to be $22,305,000 and the present value is $18,614,000. These costs are based on a DAPL volume of 13.3 million gallons and up to twelve extraction wells.

## 4.0 COMPARATIVE ANALYSIS OF ALTERNATIVES: SECTION 4.6.2

This section presents the comparative analysis of the DAPL alternatives:

- DAPL 1: No further action.
- DAPL 2: DAPL extraction in the OPWD DAPL pool:
    - DAPL 2A: one replacement extraction well.
    - DAPL 2B: four extraction wells.
- DAPL 3: DAPL extraction in the Containment Area DAPL pool:
    - DAPL 3A: one extraction well.
    - DAPL 3B: four extraction wells.
- DAPL 4: DAPL extraction in the Main Street DAPL pool:
    - DAPL 4A: three extraction wells.
    - DAPL 4B: twelve extraction wells

The comparative analysis for each DAPL pool is included in the following subsections. Each of the subsections compare the no-further-action alternative (DAPL 1) to two DAPL extraction alternatives. The comparative analysis is summarized in Table 5a, 5b, and 5c for the OPWD DAPL pool, the Containment Area DAPL pool, and the Main Street DAPL pool, respectively.

### 4.1 Overall Protection of Human Health and the Environment: Section 4.6.2.1

The following subsections compare the alternatives for each DAPL pool with respect to overall protection of human health and the environment.

#### 4.1.1 OPWD DAPL Pool

Alternative DAPL 1 does not provide any provisions to prevent receptors' contact with DAPL or reduce the potential of DAPL as a source of contamination to groundwater. Alternative DAPL 2A and DAPL 2B both include institutional controls to prevent human contact while the DAPL pool is in place, and both would remove DAPL as a potential source to groundwater. Alternative DAPL 2B would address the deepest portion of the OPWD DAPL pool beneath the building at Jewel Drive and would be able to capture more residual material. Alternative DAPL 2A is assumed to address 95% of the DAPL pool volume addressed by DAPL 2B.

#### 4.1.2 Containment Area DAPL Pool

Alternative DAPL 1 does not provide any provisions to prevent receptors' contact with DAPL or reduce the potential of DAPL as a source of contamination to groundwater. Alternative DAPL 3A and DAPL 3B both include institutional controls to prevent human contact while the DAPL pool is in place, and both would remove DAPL as a potential source to groundwater. Alternative DAPL 3B has the potential to target more bedrock depressions than Alternative DAPL 3A and therefore remove more of the residual DAPL on top of bedrock. Alternative DAPL 3A is assumed to address 95% of the DAPL pool volume addressed by DAPL 2B.

#### 4.1.3 Main Street DAPL Pool

Alternative DAPL 1 does not provide any provisions to prevent receptors' contact with DAPL or reduce the potential of DAPL as a source of contamination to groundwater. Alternative DAPL 4A and DAPL 4B both include institutional controls to prevent human contact while the DAPL pool is in place, and both would remove DAPL as a potential source to groundwater. Alternative DAPL 4B has the potential to target more areas within the DAPL pool and therefore remove the largest volume of the residual DAPL on top of bedrock. Given the large area of the Main Street DAPL pool and the expected variability of the bedrock surface topography, a larger number of extraction wells for Alternative DAPL 4B would ensure that more isolated areas would be addressed, reducing the amount of DAPL remaining to serve a source of contamination to groundwater and to downgradient receptors. Alternative DAPL 4A is assumed to address 95% of the Main Street DAPL pool volume addressed by DAPL 2B.

## 4.2 Compliance with ARARs: Section 4.6.2.2

The following subsections compare the alternatives for each DAPL pool with respect to compliance with ARARs.

### 4.2.1 OPWD DAPL Pool

DAPL 1 does not have chemical-specific ARARs. DAPL 2A and DAPL 2B are interim actions that are not based on attainment of concentrations of specific chemical-specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. Of these two alternatives, DAPL 2B is expected to remove more residual DAPL on top of bedrock.

Alternative DAPL 1 does not have activity- or location-specific ARARs. Alternatives DAPL 2A and DAPL 2B would be designed and implemented to comply with action- and location-specific ARARs that are similar for both alternatives.

### 4.2.2 Containment Area DAPL Pool

DAPL 1 does not have chemical-specific ARARs. DAPL 3A and DAPL 3B are interim actions that are not based on attainment of concentrations of specific chemical-specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. Of these two alternatives, DAPL 3B may remove more residual DAPL on top of bedrock.

Alternative DAPL 1 does not have activity- or location-specific ARARs. Alternatives DAPL 3A and DAPL 3B would be designed and implemented to comply with action- and location-specific ARARs, which are similar for both alternatives.

#### 4.2.3 Main Street DAPL Pool

DAPL 1 does not have chemical-specific ARARs. DAPL 4A and DAPL 4B are interim actions that are not based on attainment of concentrations of specific chemical-specific ARARs. Instead, DAPL will be removed to the extent practicable based on measured concentrations meeting the definition of DAPL. Of these two alternatives, DAPL 4B is expected to remove more residual DAPL on top of bedrock.

Alternative DAPL 1 does not have activity- or location-specific ARARs. Alternatives DAPL 4A and DAPL 4B would be designed and implemented to comply with action- and location-specific ARARs, which are similar for both alternatives.

### 4.3 Long-Term Effectiveness and Permanence: Section 4.6.2.4

The following subsections compare the alternatives for each DAPL pool with respect to long-term effectiveness and permanence.

#### 4.3.1 OPWD DAPL Pool

Alternative DAPL 1 is not effective in the long term, as it would allow contaminants to continue to migrate to the southeast and impact groundwater, surface water, and sediments. Alternatives DAPL 2A and DAPL 2B would permanently remove DAPL and its associated COCs.

DAPL 2B would be more effective than DAPL 2A in the long term because the DAPL extraction would directly target the area of deepest bedrock, and therefore remove more DAPL resting on bedrock. It is assumed that DAPL 2A would address 95% of the DAPL volume addressed by DAPL 2B; a PDI will provide additional data to revise this estimate (along with a revised DAPL volume).

#### 4.3.2 Containment Area DAPL Pool

Alternative DAPL 1 is not effective in the long term because DAPL may migrate away from the Containment Area via bedrock fractures and from beneath the slurry wall. DAPL may also serve as a source of contamination to groundwater via the equalization window within the slurry wall. Alternatives DAPL 3A and DAPL 3B would permanently remove DAPL and its associated COCs.

DAPL 3B would be more effective than DAPL 3A in the long term because the DAPL extraction would target multiple low spots in the bedrock and therefore remove more of the deepest DAPL material. It is assumed that DAPL 3A would address 95% of the DAPL volume addressed by DAPL 3B; a PDI will provide additional data to revise this estimate (along with a revised DAPL volume).

#### 4.3.3 Main Street DAPL Pool

Alternative DAPL 1 is not effective in the long term, as it would allow contaminants to continue to migrate to the MMBW. Alternatives DAPL 4A and DAPL 4B would permanently remove DAPL and its associated COCs. It is assumed that DAPL 4A would address 95% of the DAPL volume addressed by DAPL 4B; a PDI will provide additional data to revise this estimate (along with a revised DAPL volume).

DAPL 4B would be much more effective than DAPL 4A in the long term because DAPL 4A would only address 3 bedrock low spots in an approximately 20-acre area of known high bedrock variability. The increased number of DAPL extraction wells in DAPL 4B would allow for multiple isolated areas and bedrock low spots to be targeted and for the full extent of the DAPL pool to be addressed.

### 4.4 Reduction in Toxicity, Mobility, or Volume through Treatment: Section 4.6.2.5

The following subsections compare the alternatives for each DAPL pool with respect to reduction in toxicity, mobility, or volume through treatment.

#### 4.4.1 OPWD DAPL Pool

Alternative DAPL 1 does not appreciably reduce toxicity, mobility, or volume. Some natural attenuation may reduce the volume of contamination via breakdown of organics and precipitation of inorganics, but this volume would be negligible. Alternatives DAPL 2A and DAPL 2B would address an approximately 1.3 million-gallon DAPL pool; however, DAPL 2A is expected to be less effective and to leave residual DAPL in areas of deeper bedrock, such as beneath the building. DAPL 2B is expected to remove a slightly larger volume of DAPL (100% of accessible DAPL for 2B compared to 95% of accessible DAPL for 2A).

### 4.4.2 Containment Area DAPL Pool

Alternative DAPL 1 does not appreciably reduce toxicity, mobility, or volume. Some natural attenuation may reduce the volume of contamination via breakdown of organics and precipitation of inorganics, but this volume would be negligible. Alternatives DAPL 3A and DAPL 3B would address an approximately 240,000-gallon DAPL pool; however, DAPL 3A is expected to be less effective and to leave some residual DAPL in areas of deeper bedrock. DAPL 3B is expected to remove a slightly larger volume of DAPL (100% of accessible DAPL for 3B compared to 95% of accessible DAPL for 3A).

### 4.4.3 Main Street DAPL Pool

Alternative DAPL 1 does not appreciably reduce toxicity, mobility, or volume. Some natural attenuation may reduce the volume of contamination via breakdown of organics and precipitation of inorganics, but this volume would be negligible. Alternatives DAPL 4A and DAPL 4B would address an approximately 13.3 million-gallon DAPL pool. However, Alternative DAPL 4B would address more bedrock low spots and more isolated areas and would have better aerial coverage of the DAPL pool via more extraction wells to reduce the amount of residual DAPL remaining. Alternative DAPL 4B (100% of accessible DAPL) is therefore expected to remove a higher volume of DAPL than DAPL 4A (95% of accessible DAPL).

## 4.5 Short-Term Effectiveness: Section 4.6.2.3

The following subsections compare the alternatives for each DAPL pool with respect to short-term effectiveness.

### 4.5.1 OPWD DAPL Pool

Alternative DAPL 1 is not effective in the short term and would not remediate the remaining portion of the DAPL pool, allowing the DAPL to act as a continuing source of contamination to groundwater. However, because no further actions would be performed, there would be no additional risks to workers, the community, or the environment from remedial work.

Alternative DAPL 2B is more effective than Alternative DAPL 2A over the short term for the following reasons:

- The central extraction well will allow the DAPL extraction to be targeted to areas with the deepest bedrock and the most DAPL, particularly the area beneath the building.
- The use of additional extraction wells allows more flexibility in adjusting flow rates and for nearby extraction well(s) to be used to continue pumping if a well is clogged or otherwise compromised.
- The overall time to complete remediation would be reduced with the use of additional extraction wells.

Alternative DAPL 2B would have slightly higher risks to the community, site workers, and the environment than Alternative DAPL 2A because extraction wells would be installed beneath the building and other active working areas. These risks are low and would be mitigated using BMPs.

#### 4.5.2 Containment Area DAPL Pool

Alternative DAPL 1 is not effective in the short term and would not remediate the DAPL pool, allowing the DAPL to act as a potential source of contamination to groundwater via underflow beneath the slurry wall, bedrock fractures, and diffusion through the equalization window. However, because no further actions would be performed, there would be no additional risks to workers, the community, or the environment from remedial work.

Alternative DAPL 3B is more effective than Alternative DAPL 3A over the short term for the following reasons:

- The use of additional extraction wells will allow the DAPL extraction to be targeted to individual low spots in the bedrock surface and any isolated sub-basins.
- The use of additional extraction wells allows more flexibility in adjusting flow rates and for nearby extraction well(s) to be used to continue pumping if a well is clogged or otherwise compromised.
- The overall time to complete remediation would be reduced with the use of additional extraction wells.

Alternative DAPL 3B would have marginally higher risks to the community, site workers, and the environment than Alternative DAPL 3A because more extraction wells would be installed. These risks are extremely low and would be mitigated using BMPs.

#### 4.5.3 Main Street DAPL Pool

Alternative DAPL 1 is not effective in the short term and would not remediate the DAPL pool, allowing the DAPL to act as a continuing source of contamination to groundwater. However, because no further actions would be performed, there would be no additional risks to workers, the community, or the environment from remedial work.

Alternative DAPL 4B is more effective than Alternative DAPL 4A over the short term for the following reasons:

- Additional extraction wells will allow more bedrock low spots to be targeted. Existing bedrock data in this area indicate that the bedrock surface topography is highly varied, with potential sub-basins that may be isolated from the main body of DAPL. More bedrock low spots would be targeted with more extraction wells.
- The use of additional extraction wells allows for more flexibility in adjusting flow rates as needed across discrete areas throughout the entirety of the DAPL pool. Likewise, nearby extraction wells may be used to continue pumping if an individual well is clogged or otherwise compromised. The combination of these two factors provides additional efficiency and redundancy not afforded by Alternative 4A.

Alternatives DAPL 4A and DAPL 4B would have similar risks to the community, site workers, and the environment during implementation of the remedial action, but DAPL 4B would have more impact because more extraction wells would be installed (more intensive construction). These risks are low and would be mitigated using BMPs.

### 4.6 Implementability: Section 4.6.2.6

The following subsections compare the alternatives for each DAPL pool with respect to implementability.

#### 4.6.1 OPWD DAPL Pool

Alternative DAPL 1 has no remedial components and is the most readily implementable alternative. The active alternatives (DAPL 2A and DAPL 2B) are straightforward to implement, and the technologies, equipment, and materials proposed are readily available and sufficiently demonstrated for use. Of the two active alternatives, DAPL 2A has fewer extraction wells and would target the more readily accessible portions of the DAPL pool, and therefore would be easier to implement than DAPL 2B.

#### 4.6.2 Containment Area DAPL Pool

Alternative DAPL 1 has no remedial components and is the most readily implementable alternative. The other alternatives are straightforward to implement, and the technologies, equipment, and materials proposed are readily available and sufficiently demonstrated for use. Of the two active alternatives, DAPL 3A has fewer extraction wells. However, there are no barriers to installing extraction wells within the containment area, and therefore DAPL 3B is considered only marginally more difficult to implement than DAPL 3A.

#### 4.6.3 Main Street DAPL Pool

Alternative DAPL 1 has no remedial components and is the most readily implementable alternative. The other alternatives are straightforward to implement, and the technologies, equipment, and materials proposed are readily available and sufficiently demonstrated for use. Of the two active alternatives, DAPL 4A has fewer extraction wells, requires less underground piping than DAPL 4B, and requires less landowner coordination and permission; therefore, DAPL 4A is considered less difficult to implement.

### 4.7 Cost: Section 4.6.2.7

The total present value of each alternative is listed below for each DAPL pool, rounded to the nearest $1,000:

- OPWD DAPL pool:
  - DAPL 1 - No further action:
    - $0;
    - 0 gallons DAPL removed;
    - Extremely long time to complete.
  - DAPL 2A - 1 well:
    - $1,656,000;
    - 1.235 million gallons of DAPL removed;
    - 11.7 years to complete.
  - DAPL 2B - 4 wells:
    - $2,215,000;

        - 1.3 million gallons of DAPL removed;
        - 3.1 years to complete.

- Containment Area DAPL pool:
    - DAPL 1 - No further action:
        - $0;
        - 0 gallons DAPL removed;
        - No time to complete.
    - DAPL 3A - 1 well:
        - $925,000;
        - 228,000 gallons of DAPL removed;
        - 2.2 years to complete.
    - DAPL 3B - 4 wells:
        - $1,564,000;
        - 240,000 gallons of DAPL removed;
        - 0.6 years to complete.

- Main Street DAPL pool:
    - DAPL 1 - No further action:
        - $0;
        - 0 gallons DAPL removed;
        - No time to complete.
    - DAPL 4A - 3 wells:
        - $11,232,000;
        - 12.635 million gallons of DAPL removed;
        - 20 years to complete.
    - DAPL 4B - 12 wells:
        - $18,614,000;
        - 13.3 million gallons of DAPL removed;
        - 5.3 years to complete.

## 5.0 REFERENCES


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EPA, 2000. A Guide to Developing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002, OSWER 9355.0-75. July.

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MACTEC, 2008. Final Interim Response Steps Work Plan, Olin Chemical Superfund Site, Wilmington, Massachusetts. August 8.

Nobis, 2019. Olin Chemical Superfund Site: Evaluation of DAPL and NDMA to support Feasibility Study review and development of DAPL and groundwater alternatives. July 19.

Wood, 2019. Draft Interim Action Feasibility Study, Olin Chemical Superfunds Site, Wilmington, Massachusetts. April.

**Table 1**
**DAPL Pool Summary**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Alternative ID | Description | Estimated DAPL Volume[1] (gal) | Assumed Per-Well Pumping Rate (gpm) | Assumed Number of Extraction Wells | Total Pumping Rate (gpm) | Operational Time | Total Pumping Rate (gal/year) | Estimated Extraction Duration[2] (years) | Treatment Residual - sludge volume[3] (gal) | Treatment Residual - sludge volume (tons) |
|---|---|---|---|---|---|---|---|---|---|---|
| DAPL 2A | OPWD (Jewel Drive) DAPL Pool | 1,235,000 | 0.25 | 1 | 0.25 | 80% | 105,120 | 11.7 | 247,000 | 1,376 |
| DAPL 2B | OPWD (Jewel Drive) DAPL Pool | 1,300,000 | 0.25 | 4 | 1 | 80% | 420,480 | 3.1 | 260,000 | 1,448 |
| DAPL 3A | Containment Area DAPL Pool | 228,000 | 0.25 | 1 | 0.25 | 80% | 105,120 | 2.2 | 45,600 | 254 |
| DAPL 3B | Containment Area DAPL Pool | 240,000 | 0.25 | 4 | 1 | 80% | 420,480 | 0.6 | 48,000 | 267 |
| DAPL 4A | Main Street DAPL Pool | 12,635,000 | 0.5 | 3 | 1.5 | 80% | 630,720 | 20.0 | 2,527,000 | 14,075 |
| DAPL 4B | Main Street DAPL Pool | 13,300,000 | 0.5 | 12 | 6 | 80% | 2,522,880 | 5.3 | 2,660,000 | 14,816 |

Notes:

1. Volume estimate based on 1/15/20 Geomega values (Table 4). "A" alternatives assumed to address 95% of the DAPL volume of associated "B" alternatives. Estimate to be refined during planned investigations.
2. Estimated duration rounded to the nearest half year.
3. Residual sludge volume assumed to be 20% of the original extracted DAPL volume.
4. gal = gallons, gpm = gallons per minute

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
|---|---|---|---|
| **Federal Criteria, Advisories, and Guidance** | | | |
| Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs); 42 USC § 112(b)(1); 40 CFR Part 61 | These regulations establish emissions standards for 189 hazardous air pollutants. | Applicable | Emissions from well drilling activities, DAPL extraction and treatment system operation, and O&M will be implemented in accordance with these requirements. |
| Clean Water Act, National Pollution Discharge Elimination System (NPDES), 40 CFR Parts 122 and 125 | These regulations include stormwater standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage and disposal facilities. The NPDES permit program also specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. | Applicable | Best management practices will be used to control and manage stormwater runoff during construction and operation of the DAPL extraction system. If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Resource Conservation and Recovery Act (RCRA), Subtitle C, 42 USC §§ 6901 et seq.; 40 CFR Parts 260-262, 264 (including Subparts B-G, I-N, W, X) and 268 | Federal standards used to identify, manage and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth. | Applicable | DAPL, treatment residuals, and any investigation derived waste (IDW) determined to be hazardous will be properly stored and disposed off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with this ARAR through appropriate design, implementation and operation. |
| RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers, 40 CFR Part 264, Subparts AA, BB, and CC | RCRA emissions standards not delegated to Massachusetts. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw (Subpart AA). Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight (Subpart BB). Standards for certain tanks and containers that treat, store, or dispose of hazardous wastes (Subpart CC). | Applicable, if hazardous waste with volatile organic concentrations (VOCs) of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC).<br><br>Relevant and Appropriate, if less than thresholds. | All DAPL determined to be a hazardous waste that contains VOCs in excess of the pertinent applicability thresholds that is extracted and stored on-site will be managed in accordance with these regulations. Under this alternative, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation. |
| SDWA Underground Injection Control (UIC) Program, 40 CFR Parts 144, 146, and 147 (Subpart W) | These regulations outline minimum program and performance standards for the UIC program. Technical criteria and standards for siting, operating, closure, and post-closure are set forth in Part 146. | Applicable, if treated effluent is injected underground | If this alternative includes underground injection of treated effluent, such injection will be treated to meet these standards. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
|---|---|---|---|
| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs), 42 USC § 300f et seq.; 40 CFR Part 141, Subparts B and G | Establish MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques. | Relevant and Appropriate | MCLs will be used to determine the extent of required institutional controls to be established under this alternative. |
| SDWA National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs), 42 USC § 300f et seq.; | Establish MCLGs for several organic and inorganic contaminants in public drinking water supplies. MCLGs specify the maximum concentration at which no known or anticipated adverse effect on humans will occur. MCLGs are non-enforceable health-based goals set equal to or lower than MCLs. | Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered | MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| EPA, Office of Water, Drinking Water Health Advisories | Health Advisories (HAs) are estimates of acceptable drinking water levels for chemical substances based on health effects information; a HA is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state and local officials. | To Be Considered | HAs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Risk Reference Doses (RfDs) | RfDs are considered to be the levels unlikely to cause significant adverse non-cancer health effects associated with a threshold mechanism of action in human exposure for a lifetime. Used in developing risk-based cleanup standards by computing human health hazard resulting from exposure to non-carcinogens at the Site. | To Be Considered | RfDs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Human Health Assessment Cancer Slope Factors (CSFs) | CSFs are estimates of the upper-bound probability on the increased cancer risk from a lifetime exposure to contaminants. Used in developing risk-based cleanup standards by computing the incremental cancer risk from exposure to contaminants at the Site. | To Be Considered | CSFs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Guidelines for Carcinogenic Risk Assessment, EPA/630/P-03/001F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, EPA/630/R-03/003F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Regional Screening Levels (RSLs) for Chemical Contamination at Superfund Sites | Provides risk-based screening levels for various environmental media and for residential and industrial exposure scenarios. | To Be Considered | These screening levels will be considered in determining the extent of required institutional controls to be established under this alternative. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
|---|---|---|---|
| Guide to Management of Investigation Derived Wastes (IDW); OSWER 9345.3-03FS (1992) | Guidance on managing IDW in a manner that ensures protection of human health and the environment. | To Be Considered | IDW generated as part of this remedial alternative will be managed in compliance with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
|---|---|---|---|
| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER 9283.1-33 (June 26, 2009) | Guidance on developing groundwater remedies at CERCLA sites. | To Be Considered | This alternative to address a source of contamination to overburden and bedrock aquifers was developed in consideration of this guidance. |
| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Hazardous Waste Regulations, 310 CMR 30.000, including 30.100 (identification and listing of hazardous waste), 30.300 (requirements for generators), 30.680 (containers), 30.690 (tanks), 30.500 (facility management standards), 30.513 (waste analysis) | Massachusetts is delegated to administer RCRA through its state regulations. These regulations address the generation, storage, treatment, and disposal of hazardous waste. The regulations for tank systems used to store or treat hazardous waste provide specifications for design and installation of tanks systems; require secondary containment, leak detection systems, and inspections; and identify general operating requirements and closure and post-closure care. | Applicable, if management of hazardous waste triggers the pertinent regulations | All DAPL treatment residuals determined to be a hazardous waste will be managed as a hazardous waste and disposed of off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with these ARARs through appropriate design, implementation, and operation. |
| Massachusetts Ambient Air Quality Standards, 310 CMR 6.00 | These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Air Pollution Control Regulations, 310 CMR 7.00 | These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (310 CMR 7.06); dust, odor, construction and demolition (310 CMR 7.09); noise (310 CMR 7.10); and volatile organic compounds (310 CMR 7.18). Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Contingency Plan, Implementation of Activity and Use Limitations, 310 CMR 40.1070(4) | Establish standards for the use of Notice of Activity and Use Limitations (NAUL), a form of institutional control, at CERCLA sites in Massachusetts. | Applicable, if this form of IC is implemented | This alternative includes the use of institutional controls such as NAULs or a Town ordinance to prevent human exposure to DAPL containing Site contaminants in groundwater. If NAULs are implemented, they will comply with this regulation. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
|---|---|---|---|
| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations; MGL c. 21, §§ 26-53; 314 CMR 3.00 | These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00). | Applicable, if treated effluent is discharged to a surface water | If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Massachusetts Drinking Water Regulations, 310 CMR 22.00 | Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts MCLs and MCLGs are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria. | Relevant and Appropriate; MCLGs set as zero are To Be Considered | Massachusetts MCLs and MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, Method 1 GW-1 Standards | The MCP Method 1 groundwater standards assume exposure to concentrations of hazardous materials in groundwater under current or foreseeable future conditions. These standards contain a list of numerical, risk-based limitations on particular contaminants in groundwater based on the groundwater classification. | To Be Considered | The MCP Method 1 groundwater standards will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Drinking Water Guidelines | MassDEP's Office of Research and Standards issues guidance for chemicals other than those with Massachusetts MCLs in drinking water. | To Be Considered | These guidelines will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, Prepared for Massachusetts Executive Office of Environmental Affairs (2003) | Guidance on preventing erosion and sedimentation. | To Be Considered | Best management practices suggested by this guidance will be used during drilling and construction activities to control erosion and sedimentation. |
| Massachusetts Underground Injection Control Regulations, 310 CMR 27.00 | These regulations protect underground sources of drinking water by regulating the underground injection of hazardous wastes, fluids used for extraction of minerals, oil, and energy, and any other fluids having potential to contaminate groundwater. | Applicable, if treated effluent is injected underground | If this alternative includes treatment of DAPL and subsequent underground injection of treated effluent, such injection will be treated to meet these standards. |
| Monitoring Well Guidance, WSC-310-91 | Guidance on locating, drilling, installing, sampling, and decommissioning monitoring wells. | To Be Considered | Monitoring well installation and decommissioning will comply with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance** | | | |
| Floodplain Management and Protection of Wetlands; FEMA Regulations (44 CFR Part 9) (implementing Executive Orders 11988 and 11990) | These Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires the avoidance of impacts associated with the occupancy and modification of federally designated 100-year and 500-year floodplains and the avoidance of development within the floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which include siting waste facilities in a floodplain. Requires public notice when proposing any action in or affecting a floodplain or wetlands. | Applicable, if alternative alters wetlands or floodplains | The infrastructure for DAPL extraction from the Jewel Drive DAPL Pool will not result in the occupancy or modification of the 100 or 500-year floodplain; therefore, the floodplain management requirements do not apply. If this alternative alters wetlands, it will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration . |
| Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material 33 USC § 1344(b)(1); 40 CFR Parts 230 and 231, and 33 CFR Parts 320-323 | For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered (T&E) species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. EPA must determine which alternative is the “Least Environmentally Damaging Practicable Alternative” (LEDPA) to protect wetland and aquatic resources. | Applicable, if there is a discharge of fill material into water bodies or wetlands | If there is a discharge of fill material into water bodies or wetlands, this alternative will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Fish and Wildlife Coordination Act (16 USC §§ 661 et seq.) | Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable. | Applicable, if wildlife habitat is altered | If this alternative alters wildlife habitat, it will comply with this ARAR through appropriate consultation and implementation of measures to prevent, mitigate, or compensate for project related impacts to habitat and wildlife. |
| Migratory Bird Treaty Act (16 USC §§ 703 et seq.) | Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young. | Applicable, if protected areas are present | Under this alternative, if migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| National Historic Preservation Act (NHPA) and related laws, 54 USC §§ 306108, 306107, and 312502, 36 CFR Parts 65 and 800 | When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, or harm historic properties or landmarks, the substantive standards under these statutes and regulations must be met. | Applicable, if protected resource areas are present | Under this alternative, if protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. The closest potentially significant resource is the Middlesex Canal, located northwest of the Jewel Drive DAPL pool. These statutes and regulations will be followed if material associated with the Middlesex Canal is identified during intrusive work. |
| Endangered Species Act, 50 CFR §§ 17.11- 17.12; 50 CFR Part 402 | Requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat. | Applicable, if such species are present | No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats. |
| U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance, (09-07-2016). | This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity. | To Be Considered, if alternative alters wetlands | If this alternative requires alteration of federal jurisdictional wetlands, the mitigation and restoration will be conducted in accordance with this guidance. |
| Management of Undesirable Plants, 7 USC § 2814 | Requires integrated management systems to control or contain undesirable plant species or group of species using all available methods, including: preventive measures; physical or mechanical methods; biological agents; herbicide methods; and general land management practices. | Relevant and Appropriate, if wetland restoration is conducted | If any wetland restoration is conducted as part of this alternative, measures will be taken to prevent the establishment of undesirable plant species (i.e., non-native and invasive species). |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Antiquities Act (MGL c. 9, §§ 26-27C); Massachusetts Historical Commission Regulations, 950 CMR 70.00; Protection of Properties Included in the State Register of Historic Places, 950 CMR 71.00 | Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act. | Applicable, if protected resources are present | Under this alternative, if protected resource areas are identified in the work area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. |
| Wetlands Protection Act and Regulations, MGL c. 131, § 40; 310 CMR 10.00 | Regulations restrict dredging, filling, altering, or polluting inland wetland resource areas and impose performance standards for work in such areas. Protected resource areas include banks (10.54), bordering vegetated wetlands (10.55), land under water (10.56), bordering land subject to flooding (10.57) and riverfront areas (10.58). | Applicable, if alternative alters wetlands | Under this alternative, DAPL extraction may impact state regulated wetland resource areas. If this alternative alters state regulated wetland resource areas, it will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material, MGL c. 21, §§ 26-53; 314 CMR 9.00 | For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts. | Applicable, if alternative discharges dredged or fill material into wetlands | If this alternative requires alteration of wetlands, installation and maintenance of monitoring and extraction wells, access ways, and treatment systems to address DAPL will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Endangered Species Regulations, 321 CMR 10.00 | Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program. | Applicable, if such species are present | No Massachusetts-listed rare, threatened, or endangered species have been identified at the Site to date. If Massachusetts-listed rare, threatened, or endangered species in the remedial area are identified, remedial activities will avoid actions that would adversely affect such species or their habitats. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Areas of Critical Environmental Concern (ACEC), 310 CMR 12.00 | An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas. | Applicable, if ACEC is present | No known ACECs have been identified at the Site to date. If an ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species or resources. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance** | | | |
| Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs); 42 USC § 112(b)(1); 40 CFR Part 61 | These regulations establish emissions standards for 189 hazardous air pollutants. | Applicable | Emissions from well drilling activities, DAPL extration and treatment system operation, and O&M will be implemented in accordance with these requirements. |
| Clean Water Act, National Pollution Discharge Elimination System (NPDES), 40 CFR Parts 122 and 125 | These regulations include stormwater standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage and disposal facilities. The NPDES permit program also specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. | Applicable | Best management practices will be used to control and manage stormwater runoff during construction and operation of the DAPL extraction system. If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Resource Conservation and Recovery Act (RCRA), Subtitle C, 42 USC §§ 6901 et seq.; 40 CFR Parts 260-262, 264 (including Subparts B-G, I-N, W, X) and 268 | Federal standards used to identify, manage and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth. | Applicable | DAPL, treatment residuals, and any investigation derived waste (IDW) determined to be hazardous will be properly stored and disposed off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with this ARAR through appropriate design, implementation and operation. |
| RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers, 40 CFR Part 264, Subparts AA, BB, and CC | RCRA emissions standards not delegated to Massachusetts. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw (Subpart AA). Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight (Subpart BB). Standards for certain tanks and containers that treat, store, or dispose of hazardous wastes (Subpart CC). | Applicable, if hazardous waste with volatile organic concentrations (VOCs) of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC).<br><br>Relevant and Appropriate, if less than thresholds. | All DAPL treatment residuals determined to be a hazardous waste that contains VOCs in excess of the pertinent applicability thresholds that is extracted and stored on-site will be managed in accordance with these regulations. Under this alternative, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation. |
| SDWA Underground Injection Control (UIC) Program, 40 CFR Parts 144, 146, and 147 (Subpart W) | These regulations outline minimum program and performance standards for the UIC program. Technical criteria and standards for siting, operating, closure, and post-closure are set forth in Part 146. | Applicable, if treated effluent is injected underground | If this alternative includes underground injection of treated effluent, such injection will be treated to meet these standards. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs), 42 USC § 300f et seq.; 40 CFR Part 141, Subparts B and G | Establish MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques. | Relevant and Appropriate | MCLs will be used to determine the extent of required institutional controls to be established under this alternative. |
| SDWA National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs), 42 USC § 300f et seq.; | Establish MCLGs for several organic and inorganic contaminants in public drinking water supplies. MCLGs specify the maximum concentration at which no known or anticipated | Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered | MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| EPA, Office of Water, Drinking Water Health Advisories | Health Advisories (HAs) are estimates of acceptable drinking water levels for chemical substances based on health effects information; a HA is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state and local officials. | To Be Considered | HAs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Risk Reference Doses (RfDs) | RfDs are considered to be the levels unlikely to cause significant adverse non-cancer health effects associated with a threshold mechanism of action in human exposure for a lifetime. Used in developing risk-based cleanup standards by computing human health hazard resulting from exposure to non-carcinogens at the Site. | To Be Considered | RfDs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Human Health Assessment Cancer Slope Factors (CSFs) | CSFs are estimates of the upper-bound probability on the increased cancer risk from a lifetime exposure to contaminants. Used in developing risk-based cleanup standards by computing the incremental cancer risk from exposure to contaminants at the Site. | To Be Considered | CSFs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Guidelines for Carcinogenic Risk Assessment, EPA/630/P-03/001F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, EPA/630/R-03/003F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Regional Screening Levels (RSLs) for Chemical Contamination at Superfund Sites | Provides risk-based screening levels for various environmental media and for residential and industrial exposure scenarios. | To Be Considered | These screening levels will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Guide to Management of Investigation Derived Wastes (IDW); OSWER 9345.3-03FS (1992) | Guidance on managing IDW in a manner that ensures protection of human health and the environment. | To Be Considered | IDW generated as part of this remedial alternative will be managed in compliance with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER 9283.1-33 (June 26, 2009) | Guidance on developing groundwater remedies at CERCLA sites. | To Be Considered | This alternative to address a source of contamination to overburden and bedrock aquifers was developed in consideration of this guidance. |
| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Hazardous Waste Regulations, 310 CMR 30.000, including 30.100 (identification and listing of hazardous waste), 30.300 (requirements for generators), 30.680 (containers), 30.690 (tanks), 30.500 (facility management standards), 30.513 (waste analysis) | Massachusetts is delegated to administer RCRA through its state regulations. These regulations address the generation, storage, treatment, and disposal of hazardous waste. The regulations for tank systems used to store or treat hazardous waste provide specifications for design and installation of tanks systems; require secondary containment, leak detection systems, and inspections; and identify general operating requirements and closure and post-closure care. | Applicable, if management of hazardous waste triggers the pertinent regulations | All DAPL treatment residuals determined to be a hazardous waste will be managed as a hazardous waste and disposed of off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with these ARARs through appropriate design, implementation, and operation. |
| Massachusetts Ambient Air Quality Standards, 310 CMR 6.00 | These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Air Pollution Control Regulations, 310 CMR 7.00 | These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (310 CMR 7.06); dust, odor, construction and demolition (310 CMR 7.09); noise (310 CMR 7.10); and volatile organic compounds (310 CMR 7.18). Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Contingency Plan, Implementation of Activity and Use Limitations, 310 CMR 40.1070(4) | Establish standards for the use of Notice of Activity and Use Limitations (NAUL), a form of institutional control, at CERCLA sites in Massachusetts. | Applicable, if this form of IC is implemented | This alternative includes the use of institutional controls such as NAULs or a Town ordinance to prevent human exposure to DAPL containing Site contaminants in groundwater. If NAULs are implemented, they will comply with this regulation. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations; MGL c. 21, §§ 26-53; 314 CMR 3.00 | These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00). | Applicable, if treated effluent is discharged to a surface water | If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Massachusetts Drinking Water Regulations, 310 CMR 22.00 | Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts MCLs and MCLGs are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria. | Relevant and Appropriate; MCLGs set as zero are To Be Considered | Massachusetts MCLs and MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, Method 1 GW-1 Standards | The MCP Method 1 groundwater standards assume exposure to concentrations of hazardous materials in groundwater under current or foreseeable future conditions. These standards contain a list of numerical, risk-based limitations on particular contaminants in groundwater based on the groundwater classification. | To Be Considered | The MCP Method 1 groundwater standards will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Drinking Water Guidelines | MassDEP's Office of Research and Standards issues guidance for chemicals other than those with Massachusetts MCLs in drinking water. | To Be Considered | These guidelines will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, Prepared for Massachusetts Executive Office of Environmental Affairs (2003) | Guidance on preventing erosion and sedimentation. | To Be Considered | Best management practices suggested by this guidance will be used during drilling and construction activities to control erosion and sedimentation. |
| Massachusetts Underground Injection Control Regulations, 310 CMR 27.00 | These regulations protect underground sources of drinking water by regulating the underground injection of hazardous wastes, fluids used for extraction of minerals, oil, and energy, and any other fluids having potential to contaminate groundwater. | Applicable, if treated effluent is injected underground | If this alternative includes treatment of DAPL and subsequent underground injection of treated effluent, such injection will be treated to meet these standards. |
| Monitoring Well Guidance, WSC-310-91 | Guidance on locating, drilling, installing, sampling, and decommissioning monitoring wells. | To Be Considered | Monitoring well installation and decommissioning will comply with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance** | | | |
| Floodplain Management and Protection of Wetlands; FEMA Regulations (44 CFR Part 9) (implementing Executive Orders 11988 and 11990) | These Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires the avoidance of impacts associated with the occupancy and modification of federally designated 100-year and 500-year floodplains and the avoidance of development within the floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which include siting waste facilities in a floodplain. Requires public notice when proposing any action in or affecting a floodplain or wetlands. | Applicable, if alternative alters wetlands or floodplains | The infrastructure for DAPL extraction from the Containment Area DAPL Pool will not occur in federal jurisdictional wetlands; therefore, the wetland protection requirements do not apply. This alternative will have short-term impacts on the 500-year floodplain and will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. Because most of the infrastructure (extraction wells, piping) will be installed below ground (flush to grade), the impacts to floodplain values will be minimal. |
| Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material 33 USC § 1344(b)(1); 40 CFR Parts 230 and 231, and 33 CFR Parts 320-323 | For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered (T&E) species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. EPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources. | Applicable, if there is a discharge of fill material into water bodies or wetlands | If there is a discharge of fill material into water bodies or wetlands, this alternative will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Fish and Wildlife Coordination Act (16 USC §§ 661 et seq.) | Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable. | Applicable, if wildlife habitat is altered | If this alternative alters wildlife habitat, it will comply with this ARAR through appropriate consultation and implementation of measures to prevent, mitigate, or compensate for project related impacts to habitat and wildlife. |
| Migratory Bird Treaty Act (16 USC §§ 703 et seq.) | Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young. | Applicable, if protected areas are present | Under this alternative, if migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| National Historic Preservation Act (NHPA) and related laws, 54 USC §§ 306108, 306107, and 312502, 36 CFR Parts 65 and 800 | When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, or harm historic properties or landmarks, the substantive standards under these statutes and regulations must be met. | Applicable, if protected resource areas are present | Under this alternative, if protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. The closest potentially significant resource is the Middlesex Canal, located northwest of the Containment Area DAPL pool. These statutes and regulations will be followed if material associated with the Middlesex Canal is identified during intrusive work. |
| Endangered Species Act, 50 CFR §§ 17.11- 17.12; 50 CFR Part 402 | Requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat. | Applicable, if such species are present | No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats. |
| U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016). | This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity. | To Be Considered, if alternative alters wetlands | If this alternative requires alteration of federal jurisdictional wetlands, the mitigation and restoration will be conducted in accordance with this guidance. |
| Management of Undesirable Plants, 7 USC § 2814 | Requires integrated management systems to control or contain undesirable plant species or group of species using all available methods, including: preventive measures; physical or mechanical methods; biological agents; herbicide methods; and general land management practices. | Relevant and Appropriate, if wetland restoration is conducted | If any wetland restoration is conducted as part of this alternative, measures will be taken to prevent the establishment of undesirable plant species (i.e., non-native and invasive species). |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Antiquities Act (MGL c. 9, §§ 26-27C); Massachusetts Historical Commission Regulations, 950 CMR 70.00; Protection of Properties Included in the State Register of Historic Places, 950 CMR 71.00 | Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act. | Applicable, if protected resources are present | Under this alternative, if protected resource areas are identified in the work area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. |
| Wetlands Protection Act and Regulations, MGL c. 131, § 40; 310 CMR 10.00 | Regulations restrict dredging, filling, altering, or polluting inland wetland resource areas and impose performance standards for work in such areas. Protected resource areas include banks (10.54), bordering vegetated wetlands (10.55), land under water (10.56), bordering land subject to flooding (10.57) and riverfront areas (10.58). | Applicable, if alternative alters wetlands | Under this alternative, DAPL extraction may impact state regulated wetland resource areas. If this alternative alters state regulated wetland resource areas, it will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material, MGL c. 21, §§ 26-53; 314 CMR 9.00 | For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts. | Applicable, if alternative discharges dredged or fill material into wetlands | If this alternative requires alteration of wetlands, installation and maintenance of monitoring and extraction wells, access ways, and treatment systems to address DAPL will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Endangered Species Regulations, 321 CMR 10.00 | Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program. | Applicable, if such species are present | No Massachusetts-listed rare, threatened, or endangered species have been identified at the Site to date. If Massachusetts-listed rare, threatened, or endangered species in the remedial area are identified, remedial activities will avoid actions that would adversely affect such species or their habitats. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Areas of Critical Environmental Concern, 310 CMR 12.00 | An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas. | Applicable, if ACEC is present | No known ACECs have been identified at the Site to date. If an ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species or resources. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance** | | | |
| Clean Air Act, National Emission Standards for Hazardous Air Pollutants (NESHAPs); 42 USC § 112(b)(1); 40 CFR Part 61 | These regulations establish emissions standards for 189 hazardous air pollutants. | Applicable | Emissions from well drilling activities, DAPL extraction and treatment system operation, and O&M will be implemented in accordance with these requirements. |
| Clean Water Act, National Pollution Discharge Elimination System (NPDES), 40 CFR Parts 122 and 125 | These regulations include stormwater standards for construction activities disturbing more than one acre and requirements for stormwater discharges from hazardous waste treatment, storage and disposal facilities. The NPDES permit program also specifies the permissible concentration or level of contaminants in the discharge from any point source to waters of the United States. | Applicable | Best management practices will be used to control and manage stormwater runoff during construction and operation of the DAPL extraction system. If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Resource Conservation and Recovery Act (RCRA), Subtitle C, 42 USC §§ 6901 et seq.; 40 CFR Parts 260-262, 264 (including Subparts B-G, I-N, W, X) and 268 | Federal standards used to identify, manage and dispose of hazardous waste. Massachusetts has been delegated the authority to administer these RCRA standards through its state hazardous waste management regulations. These provisions have been adopted by the Commonwealth. | Applicable | DAPL, treatment residuals, and any investigation derived waste (IDW) determined to be hazardous will be properly stored and disposed off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with this ARAR through appropriate design, implementation and operation. |
| RCRA, Air Emission Standards for Process Vents, Equipment Leaks, Tanks, Surface Impoundments, and Containers, 40 CFR Part 264, Subparts AA, BB, and CC | RCRA emissions standards not delegated to Massachusetts. Standards for process vents for systems that manage hazardous wastes that have organic concentrations of at least 10 ppmw (Subpart AA). Standards for air equipment leaks for systems that manage hazardous wastes with organic concentrations of at least 10% by weight (Subpart BB). Standards for certain tanks and containers that treat, store, or dispose of hazardous wastes (Subpart CC). | Applicable, if hazardous waste with volatile organic concentrations (VOCs) of at least 10 parts per million by weight (ppmw) (Subpart AA), with organic concentrations of at least 10 % by weight (Subpart BB), will be treated, stored, or disposed of in tanks, surface impoundments, or containers, and thresholds are met (Subpart CC).<br><br>Relevant and Appropriate, if less than thresholds. | All DAPL determined to be a hazardous waste that contains VOCs in excess of the pertinent applicability thresholds that is extracted and stored on-site will be managed in accordance with these regulations. Under this alternative, any treatment or storage of hazardous waste will comply with this ARAR through appropriate design and operation. |
| SDWA Underground Injection Control (UIC) Program, 40 CFR Parts 144, 146, and 147 (Subpart W) | These regulations outline minimum program and performance standards for the UIC program. Technical criteria and standards for siting, operating, closure, and post-closure are set forth in Part 146. | Applicable, if treated effluent is injected underground | If this alternative includes underground injection of treated effluent, such injection will be treated to meet these standards. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Safe Drinking Water Act (SDWA) National Primary Drinking Water Regulations, Maximum Contaminant Levels (MCLs), 42 USC § 300f et seq.; 40 CFR Part 141, Subparts B and G | Establish MCLs for common organic and inorganic contaminants applicable to public drinking water supplies. MCLs are federally enforceable standards based in part on the availability and cost of treatment techniques. | Relevant and Appropriate | MCLs will be used to determine the extent of required institutional controls to be established under this alternative. |
| SDWA National Primary Drinking Water Regulations, Maximum Contaminant Level Goals (MCLGs), 42 USC § 300f et | Establish MCLGs for several organic and inorganic contaminants in public drinking water supplies. MCLGs specify the maximum concentration at which no known or anticipated | Relevant and Appropriate for non-zero MCLGs only; MCLGs set as zero are To Be Considered | MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| EPA, Office of Water, Drinking Water Health Advisories | Health Advisories (HAs) are estimates of acceptable drinking water levels for chemical substances based on health effects information; a HA is not a legally enforceable federal standard, but serves as technical guidance to assist federal, state and local officials. | To Be Considered | HAs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Risk Reference Doses (RfDs) | RfDs are considered to be the levels unlikely to cause significant adverse non-cancer health effects associated with a threshold mechanism of action in human exposure for a lifetime. Used in developing risk-based cleanup standards by computing human health hazard resulting from exposure to non-carcinogens at the Site. | To Be Considered | RfDs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Human Health Assessment Cancer Slope Factors (CSFs) | CSFs are estimates of the upper-bound probability on the increased cancer risk from a lifetime exposure to contaminants. Used in developing risk-based cleanup standards by computing the incremental cancer risk from exposure to contaminants at the Site. | To Be Considered | CSFs will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Guidelines for Carcinogenic Risk Assessment, EPA/630/P-03/001F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens, EPA/630/R-03/003F, March 2005 | Guidance values are to be used to evaluate the potential carcinogenic hazard to children caused by exposure to contaminants. | To Be Considered | These guidance values will be considered in determining the extent of required institutional controls to be established under this alternative. |
| EPA Regional Screening Levels (RSLs) for Chemical Contamination at Superfund Sites | Provides risk-based screening levels for various environmental media and for residential and industrial exposure scenarios. | To Be Considered | These screening levels will be considered in determining the extent of required institutional controls to be established under this alternative. |
| Guide to Management of Investigation Derived Wastes (IDW); OSWER 9345.3-03FS (1992) | Guidance on managing IDW in a manner that ensures protection of human health and the environment. | To Be Considered | IDW generated as part of this remedial alternative will be managed in compliance with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| Summary of Key Existing EPA CERCLA Policies for Groundwater Restoration, OSWER 9283.1-33 (June 26, 2009) | Guidance on developing groundwater remedies at CERCLA sites. | To Be Considered | This alternative to address a source of contamination to overburden and bedrock aquifers was developed in consideration of this guidance. |
| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Hazardous Waste Regulations, 310 CMR 30.000, including 30.100 (identification and listing of hazardous waste), 30.300 (requirements for generators), 30.680 (containers), 30.690 (tanks), 30.500 (facility management standards), 30.513 (waste analysis) | Massachusetts is delegated to administer RCRA through its state regulations. These regulations address the generation, storage, treatment, and disposal of hazardous waste. The regulations for tank systems used to store or treat hazardous waste provide specifications for design and installation of tanks systems; require secondary containment, leak detection systems, and inspections; and identify general operating requirements and closure and post-closure care. | Applicable, if management of hazardous waste triggers the pertinent regulations | All DAPL treatment residuals determined to be a hazardous waste will be managed as a hazardous waste and disposed of off-site at a licensed facility. Under this alternative, any generation, treatment, or storage of hazardous waste will comply with these ARARs through appropriate design, implementation, and operation. |
| Massachusetts Ambient Air Quality Standards, 310 CMR 6.00 | These regulations establish primary and secondary standards for emissions of sulfur dioxide, particulate matter, carbon monoxide, ozone, nitrogen dioxide, and lead. Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Air Pollution Control Regulations, 310 CMR 7.00 | These regulations set emission limits necessary to attain ambient air quality standards, including standards for visible emissions (310 CMR 7.06); dust, odor, construction and demolition (310 CMR 7.09); noise (310 CMR 7.10); and volatile organic compounds (310 CMR 7.18). Remedial activities will be implemented in accordance with these rules. No air emissions from remedial activities will cause air quality standards to be exceeded. | Applicable | Extraction and management of DAPL and any DAPL treatment will be implemented in accordance with these rules. Emission standards, including for dust, will be complied with during DAPL extraction and treatment. |
| Massachusetts Contingency Plan, Implementation of Activity and Use Limitations, 310 CMR 40.1070(4) | Establish standards for the use of Notice of Activity and Use Limitations (NAUL), a form of institutional control, at CERCLA sites in Massachusetts. | Applicable, if this form of IC is implemented | This alternative includes the use of institutional controls such as NAULs or a Town ordinance to prevent human exposure to DAPL containing Site contaminants in groundwater. If NAULs are implemented, they will comply with this regulation. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Clean Water Act; Surface Water Discharge Permit Regulations; MGL c. 21, §§ 26-53; 314 CMR 3.00 | These regulations provide that discharges to waters of the Commonwealth shall not result in exceedances of Massachusetts Surface Water Quality Standards (MSWQS) (314 CMR 4.00). | Applicable, if treated effluent is discharged to a surface water | If this alternative includes treatment of DAPL and subsequent discharge of treated effluent to a surface water, such discharge will be treated to meet the substantive discharge standards. |
| Massachusetts Drinking Water Regulations, 310 CMR 22.00 | Establishes maximum contaminant levels that apply to public drinking water supplies. Massachusetts MCLs and MCLGs are specified for numerous contaminants, including inorganic and organic chemicals. For the most part, the numerical criteria are identical to Federal SDWA MCLs and MCLGs, although there are several additional chemicals that have criteria. | Relevant and Appropriate; MCLGs set as zero are To Be Considered | Massachusetts MCLs and MCLGs will be used to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Contingency Plan (MCP), 310 CMR 40.0000, Method 1 GW-1 Standards | The MCP Method 1 groundwater standards assume exposure to concentrations of hazardous materials in groundwater under current or foreseeable future conditions. These standards contain a list of numerical, risk-based limitations on particular contaminants in groundwater based on the groundwater classification. | To Be Considered | The MCP Method 1 groundwater standards will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Drinking Water Guidelines | MassDEP's Office of Research and Standards issues guidance for chemicals other than those with Massachusetts MCLs in drinking water. | To Be Considered | These guidelines will be considered to determine the extent of required institutional controls to be established under this alternative. |
| Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, Prepared for Massachusetts Executive Office of Environmental Affairs (2003) | Guidance on preventing erosion and sedimentation. | To Be Considered | Best management practices suggested by this guidance will be used during drilling and construction activities to control erosion and sedimentation. |
| Massachusetts Underground Injection Control Regulations, 310 CMR 27.00 | These regulations protect underground sources of drinking water by regulating the underground injection of hazardous wastes, fluids used for extraction of minerals, oil, and energy, and any other fluids having potential to contaminate groundwater. | Applicable, if treated effluent is injected underground | If this alternative includes treatment of DAPL and subsequent underground injection of treated effluent, such injection will be treated to meet these standards. |
| Monitoring Well Guidance, WSC-310-91 | Guidance on locating, drilling, installing, sampling, and decommissioning monitoring wells. | To Be Considered | Monitoring well installation and decommissioning will comply with this guidance. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance** | | | |
| Floodplain Management and Protection of Wetlands; FEMA Regulations (44 CFR Part 9) (implementing Executive Orders 11988 and 11990) | These Federal Emergency Management Agency (FEMA) regulations set forth the policy, procedure and responsibilities to implement and enforce Executive Order 11988 (Floodplain Management) and Executive Order 11990 (Protection of Wetlands). Prohibits activities that adversely affect a federally-regulated wetland unless there is no practicable alternative and the proposed action includes all practicable measures to minimize harm to wetlands that may result from such use. Requires the avoidance of impacts associated with the occupancy and modification of federally designated 100-year and 500-year floodplains and the avoidance of development within the floodplain wherever there is a practicable alternative. An assessment of impacts to the 500-year floodplain is required for critical actions, which include siting waste facilities in a floodplain. Requires public notice when proposing any action in or affecting a floodplain or wetlands. | Applicable, if alternative alters wetlands or floodplains | The infrastructure for DAPL extraction from the Main Street DAPL Pool will not result in the occupancy or modification of the 100 or 500-year floodplain; therefore, the floodplain management requirements do not apply. If this alternative alters wetlands, it will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration . |
| Clean Water Act Guidelines for Specification of Disposal Sites for Dredged or Fill Material 33 USC § 1344(b)(1); 40 CFR Parts 230 and 231, and 33 CFR Parts 320-323 | For discharge of dredged or fill material into water bodies or wetlands, there must be no practicable alternative with less adverse impact on aquatic ecosystem; discharge cannot cause or contribute to violation of state water quality standards or toxic effluent standards or jeopardize threatened or endangered (T&E) species; discharge cannot significantly degrade waters of U.S.; practicable steps must be taken to minimize and mitigate adverse impacts; and impacts on flood level, flood velocity, and flood storage capacity must be evaluated. Sets standards for restoration and mitigation required as a result of unavoidable impacts to aquatic resources. EPA must determine which alternative is the "Least Environmentally Damaging Practicable Alternative" (LEDPA) to protect wetland and aquatic resources. | Applicable, if there is a discharge of fill material into water bodies or wetlands | If there is a discharge of fill material into water bodies or wetlands, this alternative will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Fish and Wildlife Coordination Act (16 USC §§ 661 et seq.) | Requires consultation with appropriate agencies to protect fish and wildlife when federal actions may alter waterways. Must develop measures to prevent and mitigate potential loss to the maximum extent practicable. | Applicable, if wildlife habitat is altered | If this alternative alters wildlife habitat, it will comply with this ARAR through appropriate consultation and implementation of measures to prevent, mitigate, or compensate for project related impacts to habitat and wildlife. |
| Migratory Bird Treaty Act (16 USC §§ 703 et seq.) | Protects migratory birds, their nests and eggs. A depredation permit issued by the U.S. Fish and Wildlife Service (USFWS) is required to take, possess, or transport migratory birds or disturb their nests, eggs, or young. | Applicable, if protected areas are present | Under this alternative, if migratory bird protected areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with appropriate USFWS officials |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **Federal Criteria, Advisories, and Guidance (cont.)** | | | |
| National Historic Preservation Act (NHPA) and related laws, 54 USC §§ 306108, 306107, and 312502, 36 CFR Parts 65 and 800 | When a federal agency finds, or is notified, that its activities in connection with a federal construction project may cause irreparable loss or destruction of significant scientific, pre-historical, historical, or archeological data, or harm historic properties or landmarks, the substantive standards under these statutes and regulations must be met. | Applicable, if protected resource areas are present | Under this alternative, if protected resource areas are identified in the site area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. The closest potentially significant resource is the Middlesex Canal, located north of the Main Street DAPL pool. These statutes and regulations will be followed if material associated with the Middlesex Canal is identified during intrusive work. |
| Endangered Species Act, 50 CFR §§ 17.11-17.12; 50 CFR Part 402 | Requires action to avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat. | Applicable, if such species are present | No endangered or threatened species have been identified at the Site to date. If endangered or threatened species in the remedial area are identified, remedial activities would avoid actions that adversely affect endangered or threatened species or their habitats. |
| U.S. Army Corps of Engineers, New England District Compensatory Mitigation Guidance (09-07-2016). | This Guidance is to be considered when compensatory mitigation to address impacts to federal jurisdiction wetlands is appropriate for a particular remedial activity. | To Be Considered, if alternative alters wetlands | If this alternative requires alteration of federal jurisdictional wetlands, the mitigation and restoration will be conducted in accordance with this guidance. |
| Management of Undesirable Plants, 7 USC § 2814 | Requires integrated management systems to control or contain undesirable plant species or group of species using all available methods, including: preventive measures; physical or mechanical methods; biological agents; herbicide methods; and general land management practices. | Relevant and Appropriate, if wetland restoration is conducted | If any wetland restoration is conducted as part of this alternative, measures will be taken to prevent the establishment of undesirable plant species (i.e., non-native and invasive species). |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance** | | | |
| Massachusetts Antiquities Act (MGL c. 9, §§ 26-27C); Massachusetts Historical Commission Regulations, 950 CMR 70.00; Protection of Properties Included in the State Register of Historic Places, 950 CMR 71.00 | Projects must eliminate, limit, or mitigate adverse effects to properties listed in the State Register of Historic Places (historic and archaeological properties). Establishes coordination with the National Historic Preservation Act. | Applicable, if protected resources are present | Under this alternative, if protected resource areas are identified in the work area, measures to avoid, minimize and/or mitigate any impacts to protected resource areas will be implemented in consultation with federal and state historic preservation officials. |
| Wetlands Protection Act and Regulations, MGL c. 131, § 40; 310 CMR 10.00 | Regulations restrict dredging, filling, altering, or polluting inland wetland resource areas and impose performance standards for work in such areas. Protected resource areas include banks (10.54), bordering vegetated wetlands (10.55), land under water (10.56), bordering land subject to flooding (10.57) and riverfront areas (10.58). | Applicable, if alternative alters wetlands | Under this alternative, DAPL extraction may impact state regulated wetland resource areas. If this alternative alters state regulated wetland resource areas, it will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Water Quality Certification for Discharge of Dredged or Fill Material, MGL c. 21, §§ 26-53; 314 CMR 9.00 | For discharges of dredged or fill material, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; appropriate and practicable steps must be taken to avoid and minimize potential adverse impacts to wetlands and land under water; stormwater discharges must be controlled with BMPs; and there must not be substantial adverse impacts to the physical, chemical, or biological integrity of surface waters. For dredging and dredged material management, there must be no practicable alternative with less adverse impact on the aquatic ecosystem; and if avoidance is not possible, then minimize, or if neither avoidance or minimization are possible, then mitigate potential adverse impacts. | Applicable, if alternative discharges dredged or fill material into wetlands | If this alternative requires alteration of wetlands, installation and maintenance of monitoring and extraction wells, access ways, and treatment systems to address DAPL will comply with this ARAR through appropriate avoidance, minimization, mitigation and restoration. |
| Massachusetts Endangered Species Regulations, 321 CMR 10.00 | Actions must be conducted in a manner that minimizes the impact to Massachusetts-listed rare, threatened, or endangered species, and species listed by the Massachusetts Natural Heritage Program. | Applicable, if such species are present | No Massachusetts-listed rare, threatened, or endangered species have been identified at the Site to date. If Massachusetts-listed rare, threatened, or endangered species in the remedial area are identified, remedial activities will avoid actions that would adversely affect such species or their habitats. |

| Requirement | Requirement Synopsis | ARAR Status | Action to Attain ARAR |
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| **State Criteria, Advisories, and Guidance (cont.)** | | | |
| Massachusetts Areas of Critical Environmental Concern, 310 CMR 12.00 | An ACEC is of regional, state, or national importance or contains significant ecological systems with critical interrelationships among a number of components. An eligible area must contain features from four or more of the following groups: (1) fisheries, (2) coastal features, (3) estuarine wetlands, (4) inland wetlands, (5) inland surface waters, (6) water supply areas (e.g., aquifer recharge area); (7) natural hazard areas (e.g., floodplain); (8) agricultural areas; (9) historical/archeological resources; (10) habitat resources (e.g., for endangered wildlife); or (11) special use areas. After an area is designated as an ACEC, the aim is to preserve and restore these areas. | Applicable, if ACEC is present | No known ACECs have been identified at the Site to date. If an ACEC is identified in the site area, activities will be controlled to minimize impacts to affected species or resources. |

| Alternative | DAPL 1: No Further Action | | DAPL 2A: OPWD DAPL Pool Extraction - 1 Well | | DAPL 2B: OPWD DAPL Pool Extraction - 4 Wells | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Threshold Criteria: Overall Protection of Human Health and the Environment** | | | | | | |
| **Protection of human health** | No | No additional risk reduction. No controls to prevent human exposure to DAPL. | Yes | Removes uncontrolled DAPL and provides ICs to prevent human exposure. | Yes | Removes uncontrolled DAPL and provides ICs to prevent human exposure. Includes additional extraction points to target the lowest portion of the DAPL pool beneath and around the building |
| **Protection of the environment** | No | Would not be protective of the environment. Remaining DAPL would be a continuing source of contamination to migrate downgradient. | Yes | Removes uncontrolled DAPL, which is a major source of contamination to downgradient groundwater. | Yes | Removes uncontrolled DAPL, which is a major source of contamination to downgradient groundwater. Includes additional extraction points to target the lowest portion of the DAPL pool. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Threshold Criteria: Compliance with ARARs** | | | | | | |
| **Compliance with chemical-specific ARARs** | No | Would not comply with chemical-specific ARARs. | Yes | Would remove DAPL, which contains concentrations above ARARs. | Yes | Would remove more residual DAPL with concentrations above ARARs. |
| **Compliance with action-specific ARARs** | N/A | There are no action-specific ARARs because no actions are proposed. | Yes | Would comply with action-specific ARARs. | Yes | Would comply with action-specific ARARs. |
| **Compliance with location-specific ARARs** | N/A | There are no location-specific ARARs because no actions are proposed. | Yes | Would comply with location-specific ARARs. | Yes | Would comply with location-specific ARARs. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Balancing Criteria: Long-Term Effectiveness and Permanence** | | | | | | |
| **Magnitude of residual risk** | | | good | DAPL removal and treatment would reduce residual risk. Existing extraction well may not be ideally located to capture DAPL. | very good | DAPL removal using multiple wells, including ones set at the deepest portion of the pool, would significantly reduce residual risk. DAPL treatment would further reduce residual risk. |
| **Adequacy and reliability of controls** | | | good | DAPL removal would permanently eliminate that material as a source. Ex-situ DAPL treatment would be well controlled. | very good | DAPL removal would permanently eliminate that material as a source. Use of multiple extraction wells would allow for better control and reliability of DAPL removal compared to DAPL 2A. Ex-situ DAPL treatment would be well controlled. |
| **Overall Score** | | | **good** | | **very good** | |
| **Balancing Criteria: Reduction of Toxicity, Mobility, and Volume Through Treatment** | | | | | | |
| **Treatment process used & materials treated** | | | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. |
| **Amount of hazardous materials removed or treated** | | | good | An estimated 1.235 million gallons of DAPL would be addressed. This is an estimated 95% of the total DAPL pool, which is estimated to be 1.3 million gallons. | very good | An estimated 1.3 million gallons of DAPL would be addressed. Extraction wells would be located to maximize removal of DAPL. |
| **Reduction in toxicity, mobility, or volume through treatment** | | | good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The treatment residuals (a solid) would be much less mobile. | very good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The treatment residuals (a solid) would be much less mobile. |
| **Degree to which the treatment is reversible** | | | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be reversible. Natural attenuation of remaining DAPL (estimated to be 5%) may be reversible. | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be reversible. Natural attenuation of any remaining DAPL may be reversible. |
| **Type and quantity of residuals remaining after treatment** | | | good | Some DAPL would remain in the subsurface after extraction, particularly in the area beneath the building. Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. | very good | Minimal DAPL would remain in the subsurface after extraction. Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. |
| **Satisfies statutory preference for treatment** | | | good | Addresses readily extractable DAPL. Does satisfy preference for treatment. | very good | Addresses extractable DAPL. Does satisfy preference for treatment. |
| **Overall Score** | | | **good** | | **very good** | |

| Alternative | DAPL 1: No Further Action | | DAPL 2A: OPWD DAPL Pool Extraction - 1 Well | | DAPL 2B: OPWD DAPL Pool Extraction - 4 Wells | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Short-Term Effectiveness** | | | | | | |
| **Risks to community during implementation of remedial action** | | | good | Well drilling would present similar (low) risks as other general construction. Risk to the community from treatment of DAPL and transport and disposal of residuals is low. | good | Well drilling would present similar (low) risks as other general construction. Risk to the community from treatment of DAPL and transport and disposal of residuals is low. |
| **Risks to workers during implementation of remedial action** | | | very good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. | good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. Slightly increased potential for worker risk compared to DAPL 2A due to more construction. |
| **Environmental impacts** | | | very good | Intrusive work needed for system construction, including underground piping. No sensitive environments have been identified in the area of intrusive work. | good | Intrusive work needed for system construction, including underground piping. Some additional piping required compared to DAPL 2A. No sensitive environments have been identified in the area of intrusive work. |
| **Sustainability** | | | fair | DAPL system modifications would use some energy and resources. DAPL extraction and treatment systems require some electricity to run over the moderate timeframe expected. Energy and transportation also required to send treatment residuals for off-site disposal. The smaller extraction network will lead to longer extraction and treatment timeframes, which equates to greater use of energy and resources. | good | DAPL extraction and treatment system modifications and additional extraction well installation would use some energy and resources, increased compared to DAPL 2A due to increased system size. DAPL extraction/treatment system requires some electricity, which would operate over a shorter timeframe compared to DAPL 2A. Energy and transportation required to send treatment residuals for off-site disposal. |
| **Time until remedial action objectives are achieved** | | | fair | Estimated time to remove DAPL is approximately 12 years. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. | very good | Estimated time to remove DAPL is approximately 3 years. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. |
| **Overall Score** | | | **good** | | **good** | |
| **Balancing Criteria: Implementability** | | | | | | |
| **Ability to construct and operate the technology** | | | good | DAPL extraction is a proven technology at the Site. Location of extraction point has no foreseeable complications. DAPL treatment feasibility will require confirmation during treatability testing. | fair | DAPL extraction is a proven technology at the Site. Location of extraction points beneath the building and in active working areas may be limited by access considerations. DAPL treatment feasibility will require confirmation during treatability testing. |
| **Reliability of the technology** | | | fair | Based on pilot test, extraction technology expected to be very reliable. However, use of a single extraction well results in a less flexible overall extraction system. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. | good | Based on pilot test, technology expected to be very reliable. Use of multiple extraction wells allows for flexibility in adjusting flow rates and system optimization. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. |
| **Ease of implementing future remedial actions, if necessary** | | | good | Future remedial actions can be readily implemented, given access considerations. | good | Future remedial actions can be readily implemented, given access considerations. |
| **Ability to monitor effectiveness of the remedy** | | | good | Planned monitoring points will monitor DAPL and groundwater. O&M will monitor system effectiveness. | very good | Additional planned monitoring points will monitor DAPL and groundwater. Monitoring points will be located underneath the building, if needed. O&M will monitor system effectiveness. |
| **Ability to obtain approvals from other agencies** | | | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. |
| **Coordination with other agencies** | | | good | System installation requires coordination with landowners and the Town. | good | System installation requires coordination with landowners and the Town. |
| **Availability of off-site treatment, storage, and disposal services** | | | good | No issues expected with availability of TSDFs for solids and other treatment residuals. | good | No issues expected with availability of TSDFs for solids and other treatment residuals. |
| **Availability of necessary equipment and specialists** | | | good | DAPL extraction uses readily available technology. Treatability testing will determine potential for DAPL treatment. | good | DAPL extraction uses readily available technology. Treatability testing will determine potential for DAPL treatment. |
| **Availability of prospective technologies** | | | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. |
| **Overall Score** | | | **good** | | **good** | |

| **Alternative** | **DAPL 1: No Further Action** | | **DAPL 2A: OPWD DAPL Pool Extraction - 1 Well** | | **DAPL 2B: OPWD DAPL Pool Extraction - 4 Wells** | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Costs** | | | | | | |
| **Total Present Value Cost** | | | **good** | $1,656,000 | **fair** | $2,215,000 |

**Notes:**
Threshold criteria (yes/no) must be met for remedy selection. Balancing criteria values (poor, fair, good, very good) based on comparison to other alternatives as well as overall effectiveness in meeting the criteria. Alternative(s) not meeting threshold criteria not carried forward for evaluation with balancing criteria.

Abbreviations:
IC = institutional control
DAPL = dense aqueous phase liquid
ARAR = applicable, relevant, and appropriate requirement
O&M = operations and maintenance
TSDF = treatment, storage and disposal facility
PDI = pre-design investigation
VOC = volatile organic compound
COC = chemical of concern

| Alternative | DAPL 1: No Further Action | | DAPL 3A: Containment Area DAPL Pool Extraction - 1 Well | | DAPL 3B: Containment Area DAPL Pool Extraction - 4 Wells | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Threshold Criteria: Overall Protection of Human Health and the Environment** | | | | | | |
| **Protection of human health** | No | No additional risk reduction. No controls to prevent human exposure to DAPL. | Yes | Removes DAPL that may migrate away from the Containment Area and provides ICs to prevent human exposure. | Yes | Removes DAPL that may migrate away from the Containment Area and provides ICs to prevent human exposure. Includes additional extraction points to target additional bedrock low spots. |
| **Protection of the environment** | No | Would not be protective of the environment. Remaining DAPL would be a continuing source of contamination to migrate downgradient. | Yes | Removes DAPL that may migrate away from the Containment Area and impact both downgradient groundwater and the South Ditch. | Yes | Removes DAPL that may migrate away from the Containment Area and impact both downgradient groundwater and the South Ditch. Includes additional extraction points to target bedrock low spots. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Threshold Criteria: Compliance with ARARs** | | | | | | |
| **Compliance with chemical-specific ARARs** | No | Would not comply with chemical-specific ARARs. | Yes | Would remove DAPL, which contains concentrations above ARARs. | Yes | Would remove more residual DAPL with concentrations above ARARs. |
| **Compliance with action-specific ARARs** | N/A | There are no action-specific ARARs because no actions are proposed. | Yes | Would comply with action-specific ARARs. | Yes | Would comply with action-specific ARARs. |
| **Compliance with location-specific ARARs** | N/A | There are no location-specific ARARs because no actions are proposed. | Yes | Would comply with location-specific ARARs. | Yes | Would comply with location-specific ARARs. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Balancing Criteria: Long-Term Effectiveness and Permanence** | | | | | | |
| **Magnitude of residual risk** | | | good | DAPL removal and treatment would reduce residual risk. Single extraction well would be located in best location overall. | very good | DAPL removal using multiple wells, including ones set at the deepest portion of the pool, would significantly reduce residual risk. DAPL treatment would further reduce residual risk. |
| **Adequacy and reliability of controls** | | | good | DAPL removal would permanently eliminate that material as a source. Ex-situ treatment of extracted DAPL would be well controlled. | very good | DAPL removal would permanently eliminate that material as a source. Use of multiple extraction wells would allow for better control and reliability of DAPL removal compared to DAPL 3A. Ex-situ treatment of extracted DAPL would be well controlled. |
| **Overall Score** | | | **good** | | **very good** | |
| **Balancing Criteria: Reduction of Toxicity, Mobility, and Volume Through Treatment** | | | | | | |
| **Treatment process used & materials treated** | | | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. |
| **Amount of hazardous materials removed or treated** | | | good | An estimated 228,000 gallons of DAPL would be addressed. This is an estimated 95% of the total DAPL pool, which is estimated to be 240,000 gallons. | very good | An estimated 240,000 gallons of DAPL would be addressed. Extraction wells would be located to maximize removal of DAPL. |
| **Reduction in toxicity, mobility, or volume through treatment** | | | good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The remaining treatment residual (a solid) would be much less mobile. | very good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The remaining treatment residual (a solid) would be much less mobile. |
| **Degree to which the treatment is reversible** | | | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be revisible. Natural attenuation of remaining DAPL (estimated to be 5%) may be reversible. | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be revisible. Natural attenuation of any remaining DAPL may be reversible. |
| **Type and quantity of residuals remaining after treatment** | | | good | Some DAPL may remain in the subsurface after extraction, Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. | very good | Minimal DAPL would remain in the subsurface after extraction. Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. |
| **Satisfies statutory preference for treatment** | | | good | Addresses readily extractable DAPL. Does satisfy preference for treatment. | very good | Addresses extractable DAPL. Does satisfy preference for treatment. |
| **Overall Score** | | | **good** | | **very good** | |

| Alternative | DAPL 1: No Further Action | | DAPL 3A: Containment Area DAPL Pool Extraction - 1 Well | | DAPL 3B: Containment Area DAPL Pool Extraction - 4 Wells | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Short-Term Effectiveness** | | | | | | |
| **Risks to community during implementation of remedial action** | | | good | All work would be performed within Olin property. Risk to the community from treatment of DAPL and transport and disposal of residuals is low. | good | All work would be performed within Olin property. Risk to the community from treatment of DAPL and transport and disposal of residuals is low. |
| **Risks to workers during implementation of remedial action** | | | very good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. | good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. Slightly increased potential for worker risk compared to DAPL 3A due to more construction. |
| **Environmental impacts** | | | very good | Intrusive work needed for system construction, including underground piping. No sensitive environments have been identified in the area of intrusive work. | good | Intrusive work needed for system construction, including underground piping. Some additional piping required compared to DAPL 3A. No sensitive environments have been identified in the area of intrusive work. |
| **Sustainability** | | | good | DAPL system modifications would use some energy and resources. DAPL extraction and treatment systems require some electricity to run over the moderate timeframe expected. Energy and transportation also required to send treatment residuals for off-site disposal. | good | DAPL extraction and treatment system modifications and additional extraction well installation would use some energy and resources, increased compared to DAPL 3A due to increased system size. DAPL extraction/treatment system requires some electricity, which would operate over a shorter timeframe compared to DAPL 3A. Energy and transportation required to send treatment residuals for off-site disposal. |
| **Time until remedial action objectives are achieved** | | | good | Estimated time to remove DAPL is approximately 2 years. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. | very good | Estimated time to remove DAPL is less than 1 year. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. |
| **Overall Score** | | | **good** | | **good** | |
| **Balancing Criteria: Implementability** | | | | | | |
| **Ability to construct and operate the technology** | | | good | DAPL extraction technology proven at the site. No access concerns for this alternative. DAPL treatment feasibility will require confirmation during treatability testing. | good | DAPL extraction technology proven at the site. No access concerns for this alternative. DAPL treatment feasibility will require confirmation during treatability testing. |
| **Reliability of the technology** | | | fair | Based on nearby pilot test, technology expected to be very reliable. Use of a single extraction well results in a less flexible overall extraction system. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. | good | Based on nearby pilot test, technology expected to be very reliable. Use of multiple extraction wells allows for flexibility in adjusting flow rates and system optimization compared to DAPL 3A. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. |
| **Ease of implementing future remedial actions, if necessary** | | | good | Future remedial actions can be readily implemented. Site redevelopment and other remedial actions in this area not expected to be a barrier to future work. | good | Future remedial actions can be readily implemented. Site redevelopment and other remedial actions in this area not expected to be a barrier to future work. |
| **Ability to monitor effectiveness of the remedy** | | | good | Planned monitoring points will monitor DAPL and groundwater. O&M will monitor system effectiveness. | very good | Additional planned monitoring points will monitor DAPL and groundwater. O&M will monitor system effectiveness. |
| **Ability to obtain approvals from other agencies** | | | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. |
| **Coordination with other agencies** | | | very good | No additional coordination required. | very good | No additional coordination required. |
| **Availability of off-site treatment, storage, and disposal services** | | | good | No issues expected with availability of TSDFs for solids and other treatment residuals. | good | No issues expected with availability of TSDFs for solids and other treatment residuals. |
| **Availability of necessary equipment and specialists** | | | good | DAPL extraction uses readily available technology. Treatability testing will determine feasibility of DAPL treatment. | good | DAPL extraction uses readily available technology. Treatability testing will determine feasibility of DAPL treatment. |
| **Availability of prospective technologies** | | | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. |
| **Overall Score** | | | **good** | | **good** | |

| **Alternative** | **DAPL 1: No Further Action** | | **DAPL 3A: Containment Area DAPL Pool Extraction - 1 Well** | | **DAPL 3B: Containment Area DAPL Pool Extraction - 4 Wells** | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Costs** | | | | | | |
| **Total Present Value Cost** | | | **good** | $925,000 | **fair** | $1,564,000 |

**Notes:**
Threshold criteria (yes/no) must be met for remedy selection. Balancing criteria values (poor, fair, good, very good) based on comparison to other alternatives as well as overall effectiveness in meeting the criteria. Alternative(s) not meeting threshold criteria not carried forward for evaluation with balancing criteria.

Abbreviations:
IC = institutional control
DAPL = dense aqueous phase liquid
ARAR = applicable, relevant, and appropriate requirement
O&M = operations and maintenance
TSDF = treatment, storage and disposal facility
PDI = pre-design investigation

Table 5c
Detailed Alternative Comparison: Main Street DAPL Pool
Olin Chemical Superfund Site
Wilmington, Massachusetts

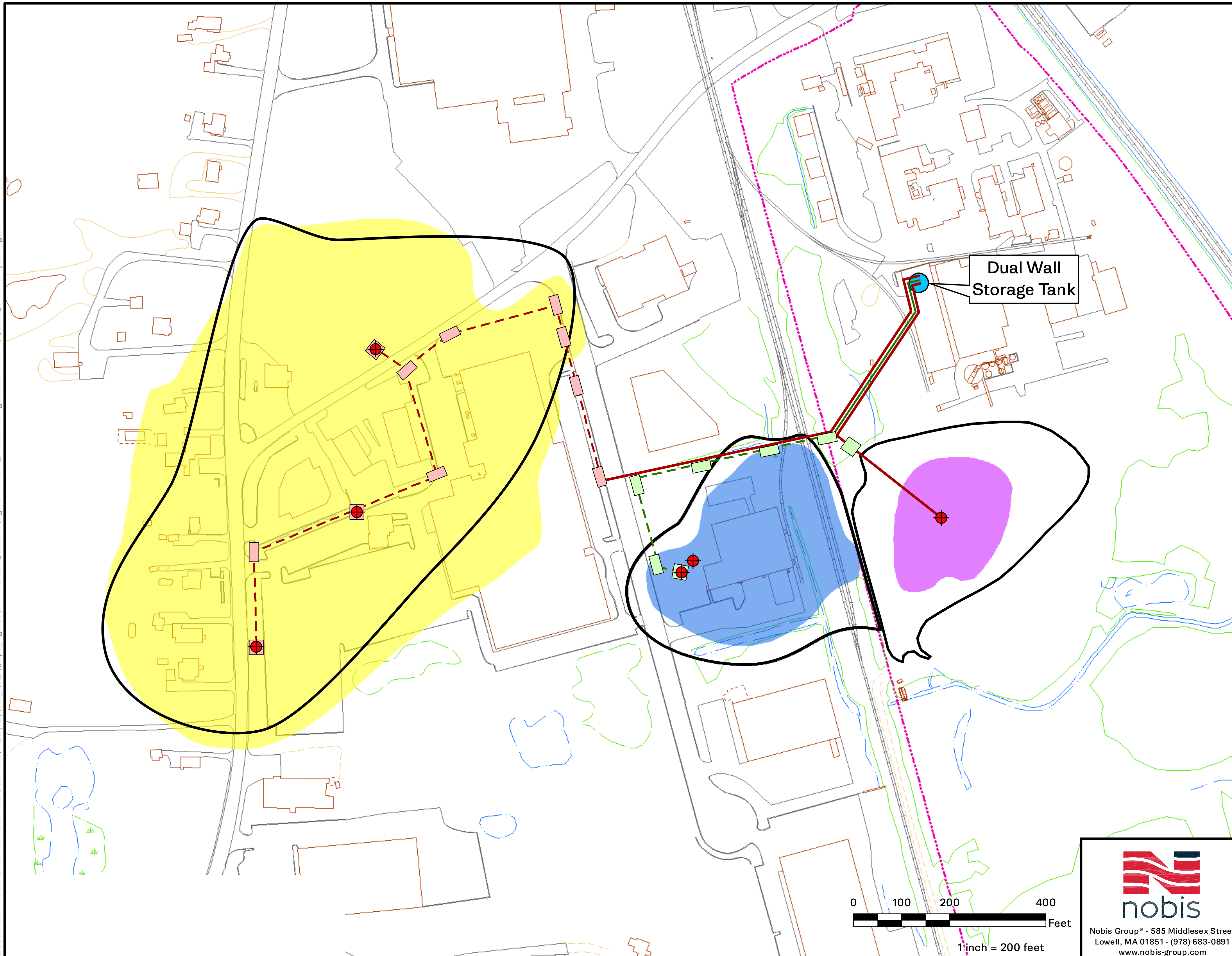

| Alternative | DAPL 1: No Further Action | | DAPL 4A: Main Street DAPL Pool Extraction - 3 Wells | | DAPL 4B: Main Street DAPL Pool Extraction - 12 Wells | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Threshold Criteria: Overall Protection of Human Health and the Environment** | | | | | | |
| **Protection of human health** | No | No additional risk reduction. No controls to prevent human exposure to DAPL. | Yes | Removes uncontrolled DAPL and provides ICs to prevent human exposure. A minimal number of extraction points would be installed to address an approximately 20-acre area. | Yes | Removes uncontrolled DAPL and provides ICs to prevent human exposure. Additional extraction point would target bedrock low spots to maximize coverage. |
| **Protection of the environment** | No | Would not be protective of the environment. Remaining DAPL would be a continuing source of contamination to migrate downgradient. | Yes | Removes uncontrolled DAPL and provides ICs to prevent continued migration of contaminants downgradient. A minimal number of extraction points would be installed to address an approximately 20-acre area. | Yes | Removes uncontrolled DAPL and provides ICs to prevent continued migration of contaminants downgradient. Additional extraction point would target bedrock low spots to maximize coverage. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Threshold Criteria: Compliance with ARARs** | | | | | | |
| **Compliance with chemical-specific ARARs** | No | Would not comply with chemical-specific ARARs. | Yes | Would remove DAPL, which contains concentrations above ARARs. | Yes | Would remove more residual DAPL with concentrations above ARARs. |
| **Compliance with action-specific ARARs** | N/A | There are no action-specific ARARs because no actions are proposed. | Yes | Would comply with action-specific ARARs. | Yes | Would comply with action-specific ARARs. |
| **Compliance with location-specific ARARs** | N/A | There are no location-specific ARARs because no actions are proposed. | Yes | Would comply with location-specific ARARs. | Yes | Would comply with location-specific ARARs. |
| **Overall Score** | **No** | | **Yes** | | **Yes** | |
| **Balancing Criteria: Long-Term Effectiveness and Permanence** | | | | | | |
| **Magnitude of residual risk** | | | good | DAPL removal and treatment would reduce residual risk. Three extraction wells would target the deepest portions of the DAPL pool. | very good | DAPL removal would further reduce residual risk compared to DAPL 4A by addressing isolated areas and bedrock low spots throughout the DAPL pool area. DAPL treatment would further reduce residual risk. |
| **Adequacy and reliability of controls** | | | good | DAPL removal would permanently eliminate that material as a source. Some residual material may remain in bedrock low spots and isolated areas. Ex-situ DAPL treatment would be well controlled. | very good | DAPL removal would permanently eliminate that material as a source. Use of multiple extraction wells would allow for better control and reliability of DAPL removal compared to DAPL 4A. Ex-situ DAPL treatment would be well controlled. |
| **Overall Score** | | | **good** | | **very good** | |
| **Balancing Criteria: Reduction of Toxicity, Mobility, and Volume Through Treatment** | | | | | | |
| **Treatment process used & materials treated** | | | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. | good | DAPL treatment processes proposed include metals lime precipitation, sludge dewatering, VOC and ammonia stripping, NDMA UV photo-oxidation, and solids evaporation. |
| **Amount of hazardous materials removed or treated** | | | good | An estimated 12.635 million gallons of DAPL would be addressed. This is an estimated 95% of the total DAPL pool, which is estimated to be 13.3 million gallons. | very good | An estimated 13.3 million gallons of DAPL would be addressed. Extraction wells would be located to maximize removal of DAPL and minimize groundwater intrusion. |
| **Reduction in toxicity, mobility, or volume through treatment** | | | good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The remaining treatment residual (a solid) would be much less mobile. | very good | DAPL extraction would reduce the mobility of the DAPL and the volume in the subsurface. DAPL treatment would remove COCs and reduce the volume of the DAPL to 20% of its original volume. The remaining treatment residual (a solid) would be much less mobile. |
| **Degree to which the treatment is reversible** | | | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be revisible. Natural attenuation of remaining DAPL (estimated to be 5%) may be reversible. | very good | Lime precipitation, air stripping, and UV oxidation are irreversible. Techniques to dewater/concentrate remaining solids may be revisible. Natural attenuation of any remaining DAPL may be reversible. |

| **Alternative** | **DAPL 1: No Further Action** | | **DAPL 4A: Main Street DAPL Pool Extraction - 3 Wells** | | **DAPL 4B: Main Street DAPL Pool Extraction - 12 Wells** | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Reduction of Toxicity, Mobility, and Volume Through Treatment (cont.)** | | | | | | |
| **Type and quantity of residuals remaining after treatment** | | | good | Some DAPL may remain in the subsurface after extraction. Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. | very good | Minimal DAPL would remain in the subsurface after extraction. Treatment would result in a solid for off-site disposal with approximately 20% of the original volume. |
| **Satisfies statutory preference for treatment** | | | good | Addresses extractable DAPL. Does satisfy preference for treatment. | very good | Addresses a large volume of extractable DAPL. Does satisfy preference for treatment. |
| **Overall Score** | | | **good** | | **very good** | |
| **Balancing Criteria: Short-Term Effectiveness** | | | | | | |
| **Risks to community during implementation of remedial action** | | | good | Well drilling would present similar (low) risks as other general construction. Risk to the community from transport and disposal of DAPL is low. | good | Well drilling would present similar (low) risks as other general construction. Risk to the community from transport and disposal of DAPL is low. |
| **Risks to workers during implementation of remedial action** | | | very good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. | good | Workers may be exposed to contaminated materials during construction and extraction/treatment system O&M. These risks are low and can be mitigated through BMPs. Slightly increased potential for worker risk compared to DAPL 4A due to more construction. |
| **Environmental impacts** | | | very good | Intrusive work needed for system construction, including underground piping. No sensitive environments have been identified in the area of intrusive work. | good | Intrusive work needed for system construction, including underground piping. More extensive piping required than for DAPL 4A. No sensitive environments have been identified in the area of intrusive work. |
| **Sustainability** | | | fair | DAPL system modifications would use some energy and resources. DAPL extraction and treatment systems require some electricity to run over the longer timeframe expected. Energy and transportation also required to send treatment residuals for off-site disposal. The smaller extraction network will lead to longer extraction and treatment timeframes, which equates to greater use of energy and resources. | good | DAPL extraction and treatment system modifications and additional extraction well installation would use some energy and resources, increased compared to DAPL 4A due to increased system size. DAPL extraction/treatment system requires some electricity, which would operate over a shorter timeframe compared to DAPL 4A. Energy and transportation required to send treatment residuals for off-site disposal. |
| **Time until remedial action objectives are achieved** | | | poor | Estimated time to remove DAPL is approximately 20 years. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. | good | Estimated time to remove DAPL is approximately 5 years. Human exposure to DAPL would be addressed with ICs in an estimated 1 year. |
| **Overall Score** | | | **good** | | **good** | |
| **Balancing Criteria: Implementability** | | | | | | |
| **Ability to construct and operate the technology** | | | good | DAPL extraction technology proven at the site. Location of extraction points may be limited by access considerations. DAPL treatment feasibility will require confirmation during treatability testing. | good | DAPL extraction technology proven at the site. Location of extraction points may be limited by access considerations. DAPL treatment feasibility will require confirmation during treatability testing. |
| **Reliability of the technology** | | | fair | Based on nearby pilot test, technology expected to be very reliable. Relatively few extraction wells result in a less flexible overall extraction system. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. | good | Based on nearby pilot test, technology expected to be very reliable. Use of more extraction wells allows for flexibility in adjusting flow rates and system optimization compared to DAPL 4A. DAPL treatment train is complex, has un-confirmed effectiveness, and may be less reliable than treatment of other sources such as hotspot groundwater. |
| **Ease of implementing future remedial actions, if necessary** | | | good | Future remedial actions can be readily implemented, given access considerations. | good | Future remedial actions can be readily implemented, given access considerations. |
| **Ability to monitor effectiveness of the remedy** | | | good | Planned monitoring points will monitor DAPL and groundwater. O&M will monitor system effectiveness. | very good | Additional planned monitoring points compared to DAPL 4A will monitor DAPL and groundwater. O&M will monitor system effectiveness. |

| **Alternative** | **DAPL 1: No Further Action** | | **DAPL 4A: Main Street DAPL Pool Extraction - 3 Wells** | | **DAPL 4B: Main Street DAPL Pool Extraction - 12 Wells** | |
|---|---|---|---|---|---|---|
| **Components** | 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | | PDI, DAPL Extraction, Treatment, ICs, O&M, monitoring, 5-Year Reviews | |
| | **Score** | **Notes** | **Score** | **Notes** | **Score** | **Notes** |
| **Balancing Criteria: Implementability (cont.)** | | | | | | |
| **Ability to obtain approvals from other agencies** | | | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. | very good | Permits not required; however, substantive ARAR requirements will be met. IC implementation is feasible. |
| **Coordination with other agencies** | | | fair | System installation requires coordination with landowners and the Town. | fair | System installation requires coordination with landowners and the Town. |
| **Availability of off-site treatment, storage, and disposal services** | | | good | No issues expected with availability of TSDFs for solids and other treatment residuals. | good | No issues expected with availability of TSDFs for solids and other treatment residuals. |
| **Availability of necessary equipment and specialists** | | | good | DAPL extraction uses readily available technology. Treatability testing will determine feasibility of DAPL treatment. | good | DAPL extraction uses readily available technology. Treatability testing will determine feasibility of DAPL treatment. |
| **Availability of prospective technologies** | | | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. | very good | Prospective extraction technologies were used previously at the Site and are widely available. Treatability studies will determine DAPL treatment feasibility. |
| **Overall Score** | | | **good** | | **good** | |
| **Costs** | | | | | | |
| **Total Present Value Cost** | | | **fair** | $11,232,000 | **poor** | $18,614,000 |

**Notes:**
Threshold criteria (yes/no) must be met for remedy selection. Balancing criteria values (poor, fair, good, very good) based on comparison to other alternatives as well as overall effectiveness in meeting the criteria. Alternative(s) not meeting threshold criteria not carried forward for evaluation with balancing criteria.

Abbreviations:
IC = institutional control
DAPL = dense aqueous phase liquid
ARAR = applicable, relevant, and appropriate requirement
O&M = operations and maintenance
TSDF = treatment, storage and disposal facility
PDI = pre-design investigation




**Notes:**

1. Main Street elevations from Olin, 2018. Slides to support December 10, 2018 team meeting. Provided December 11.

2. Containment Area elevations from Olin, 2018. Results of Containment Area Bedrock Borings, Olin Chemical Superfund Site, (OCSS), Wilmington, MA. May 10.

3. Jewel Drive Elevations from AMEC, 2015. DAPL Extraction Pilot Study Performance Evaluation Report Supplemental Water Level and Hydraulic Analysis. February 5.

4. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

## Legend

- Potential extraction well locations
- New well/piping access vault
- Existing vault
- New aboveground conveyance piping
- New underground conveyance piping
- Existing aboveground conveyance piping
- Existing underground conveyance piping

**Main St DAPL Pool Extent**

- Elev = 38.5

**Contain. Area DAPL Pool Extent**

- Elev = 51.4

**Jewel Dr DAPL Pool Extent**

- Elev = 50.6
- Paved Road
- Unpaved Road
- Rail
- Site Boundary
- Water Features
- Buildings
- Wetlands

N


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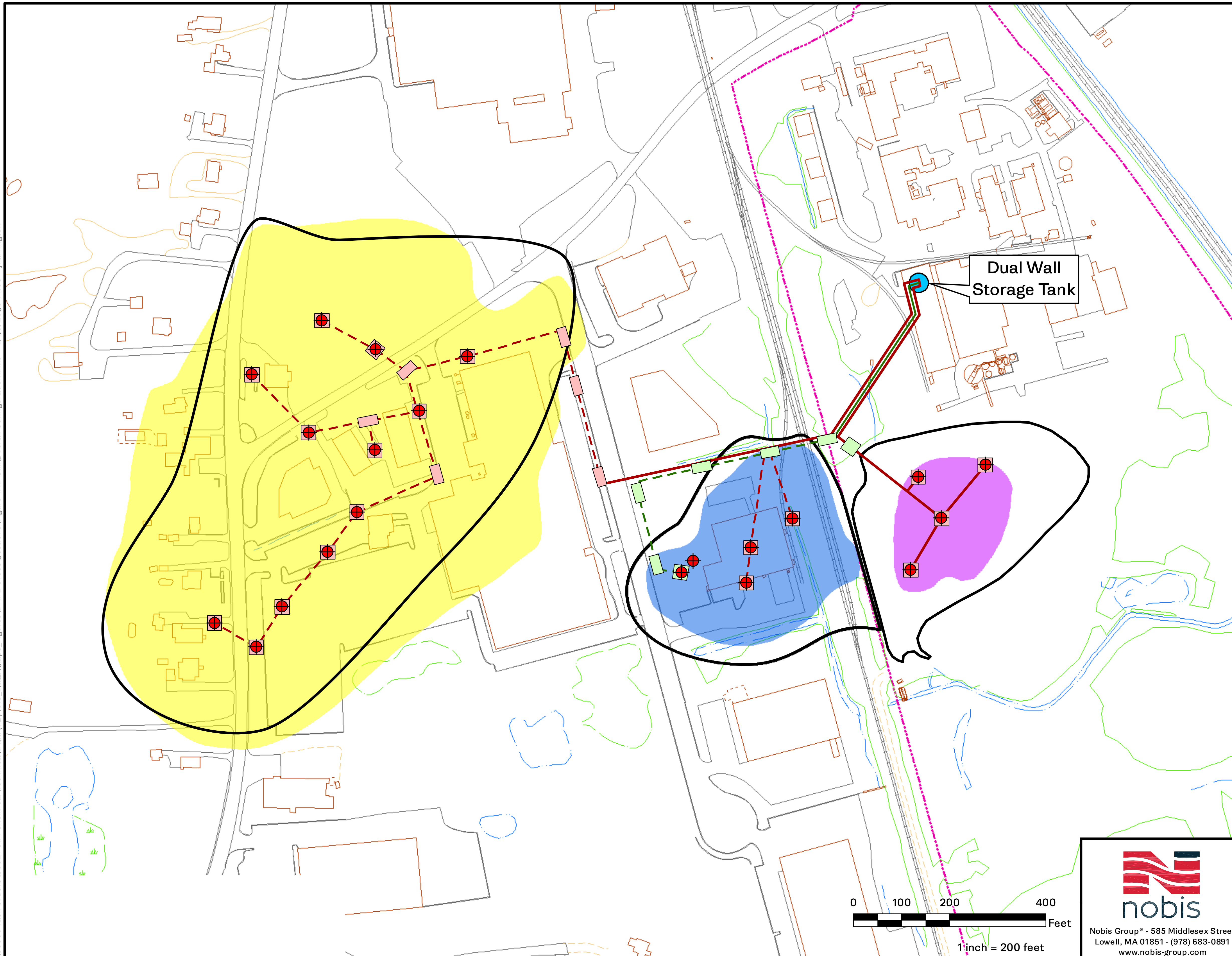
**FIGURE 1A**

OVERALL SYSTEM CONFIGURATION:
ALTERNATIVES 2A, 3A, 4A
OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

| | |
|---|---|
| PREPARED BY: JH | CHECKED BY: JB |
| PROJECT NO. 80021 | DATE: FEBRUARY 2020 |




**Notes:**

1. Main Street elevations from Olin, 2018. Slides to support December 10, 2018 team meeting. Provided December 11.

2. Containment Area elevations from Olin, 2018. Results of Containment Area Bedrock Borings, Olin Chemical Superfund Site, (OCSS), Wilmington, MA. May 10.

3. Jewel Drive Elevations from AMEC, 2015. DAPL Extraction Pilot Study Performance Evaluation Report Supplemental Water Level and Hydraulic Analysis. February 5.

4. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

## Legend

- Potential extraction well locations
- New well/piping access vault
- Existing vault
- New aboveground conveyance piping
- New underground conveyance piping
- Existing aboveground conveyance piping
- Existing underground conveyance piping

**Main St DAPL Pool Extent**

- Elev = 38.5

**Contain. Area DAPL Pool Extent**

- Elev = 51.4

**Jewel Dr DAPL Pool Extent**

- Elev = 50.6
- Paved Road
- Unpaved Road
- Rail
- Site Boundary
- Water Features
- Buildings
- Wetlands

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**FIGURE 1B**

OVERALL SYSTEM CONFIGURATION:
ALTERNATIVES 2B, 3B, 4B
OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

| | |
|---|---|
| PREPARED BY: JH | CHECKED BY: JB |
| PROJECT NO. 80021 | DATE: FEBRUARY 2020 |


**Notes:**

1. Bedrock contours from AMEC, 2015. DAPL Extraction Pilot Study Performance Evaluation Report Supplemental Water Level and Hydraulic Analysis. February 5.

2. This Site Sketch was developed from elevation data from Mactec, Amec Foster Wheeler, Wood, and observations made by Nobis.

3. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

## Legend

- Conventional Screened Well
- Bedrock Confirmation Location
- Multi-Port Well
- Induction Logging Well
- Existing Extraction Well
- DAPL 2A Proposed Extraction Well
- DAPL 2B potential DAPL extraction wells
- DPT Locations
- Most recent bedrock contours supplied by Olin
- Nobis Bedrock Contour
- Geophysical Line
- Estimated DAPL Pool Extent
- Paved Road
- Rail
- Site Boundary
- Water Features
- Buildings
- Wetlands

0 37.5 75 150 Feet

1 inch = 75 feet

N

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# FIGURE 2

ALTERNATIVE DAPL 2
JEWEL DRIVE
OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

| | |
|---|---|
| PREPARED BY: JH | CHECKED BY: JB |
| PROJECT NO. 80021 | DATE: FEBRUARY 2020 |


**Notes:**

1. Bedrock contours from Olin, 2018. Results of Containment Area Bedrock Borings, Olin Chemical Superfund Site, (OCSS), Wilmington, MA. May 10.

2. This Site Sketch was developed from elevation data from Mactec, Amec Foster Wheeler, Wood, and observations made by Nobis.

3. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

## Legend

- Conventional Screened Wells
- Bedrock Confirmation Location
- Multi-Port Well
- DAPL 3A Proposed Extraction Well
- DAPL 3B potential DAPL extraction wells
- Most recent bedrock contours supplied by Olin
- Nobis Bedrock Contour
- Geophysical Line
- Estimated DAPL Pool Extent
- Containment Area
- Paved Road
- Rail
- Site Boundary
- Water Features
- Buildings
- Wetlands

N

0 37.5 75 150
Feet
1 inch = 75 feet

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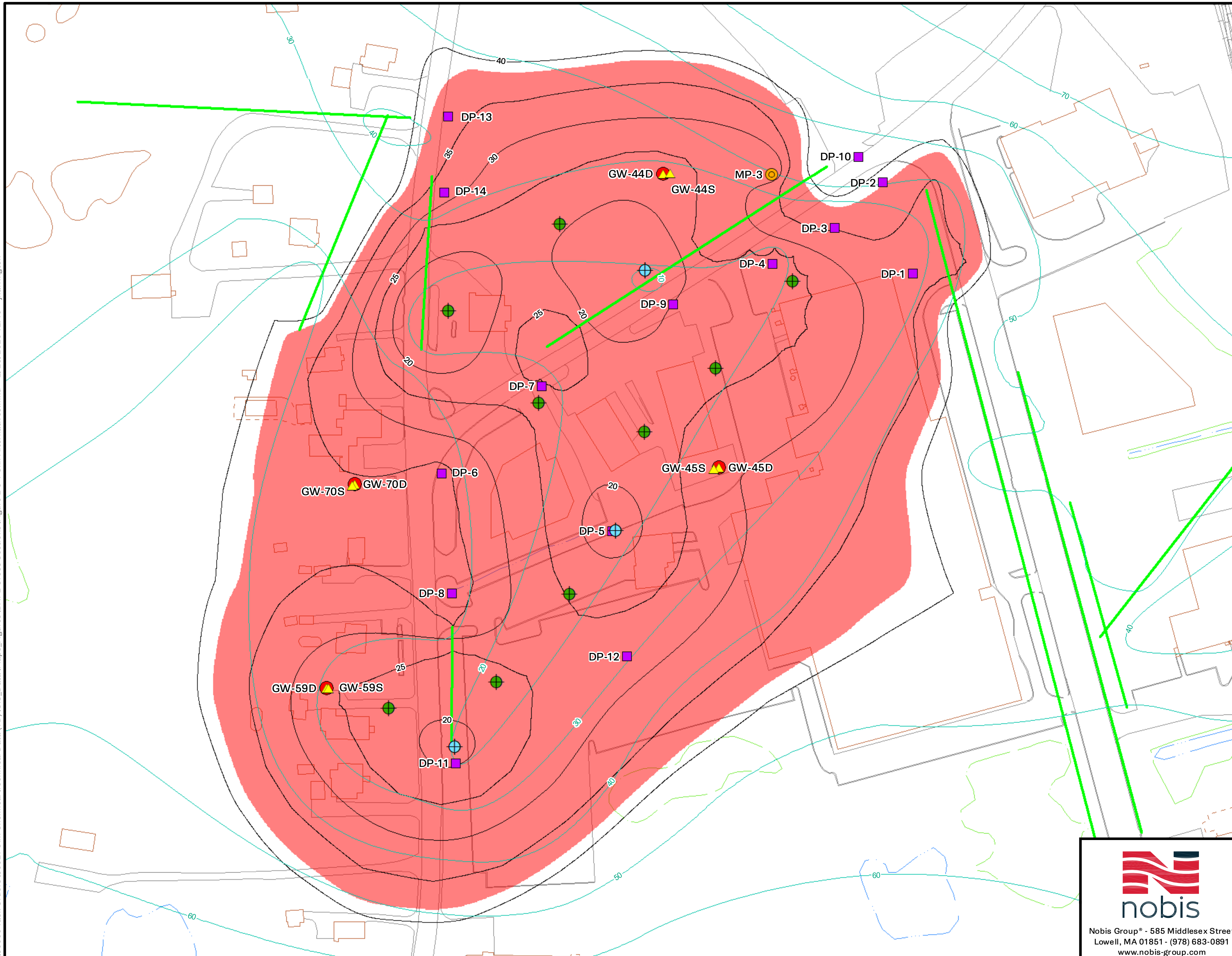
# FIGURE 3

ALTERNATIVE DAPL 3
CONTAINMENT AREA
OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

| | |
|---|---|
| PREPARED BY: JH | CHECKED BY: JB |
| PROJECT NO. 80021 | DATE: FEBRUARY 2020 |




**Notes:**

1. Bedrock contours from Olin, 2018. Slides to support December 10, 2018 team meeting. Provided December 11.

2. This Site Sketch was developed from elevation data from Mactec, Amec Foster Wheeler, Wood, and observations made by Nobis.

3. Locations of site features depicted hereon are approximate and given for illustrative purposes only.

## Legend

- Bedrock Confirmation Location
- Multi-Port Well
- Conventional Screened Well
- DPT Locations
- DAPL 4A proposed extraction well
- DAPL 4B potential DAPL extraction well
- Geophysical Line
- Estimated DAPL Pool Extent
- Most recent bedrock contours supplied by Olin
- Nobis Bedrock Contour
- Paved Road
- Rail
- Site Boundary
- Water Features
- Buildings
- Wetlands

0 50 100 200

Feet

1 inch = 125 feet

N


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**FIGURE 4**

ALTERNATIVE DAPL 4
MAIN STREET
OLIN CHEMICAL SUPERFUND SITE
WILMINGTON, MASSACHUSETTS

| PREPARED BY: JH | CHECKED BY: JB |
|---|---|
| PROJECT NO. 80021 | DATE: FEBRUARY 2020 |

F:\80000 Task Orders\80021 Olin Chemical\Technical Data (TD)\GIS_Data\Maps_Figures\DAPL Cross Sections\Figure 2 3 4 Olin Alternatives.mxd 2/20/2020 12:40 jharrington

**Attachment A-1**
**Jewel Drive/OPWD DAPL Pool (Alternative 2A) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Replacement DAPL Extraction Well | $45,000 | LS | 1 | $45,000 |
| Geophysical Investigation | $15,000 | LS | 1 | $15,000 |
| Additional DAPL Extraction Well(s) | | | | |
| Mobilization | $16,000 | LS | 1 | $16,000 |
| Temporary Facilities and Controls | $13,500 | LS | 1 | $13,500 |
| Pump Enclosure Vault | $31,000 | LS | 1 | $31,000 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 1 | $31,000 |
| Underground DAPL Discharge Piping | $168 | LF | 200 | $33,600 |
| Electrical and Instrumentation Systems | $175,000 | LS | 0.25 | $43,750 |
| Multi-Port Monitoring Wells | $35,000 | LS | 1 | $35,000 |
| Induction Logging Wells | $8,000 | LS | 1 | $8,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $226,850 |
| Contingency | | | 20% | $45,370 |
| Total Capital Costs | | | | $332,220 |
| **Annual Costs** | | | | |
| Electricity | $900 | month | 12 | $10,800 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 105,120 | $137,707 |
| System Performance Monitoring | $1,440 | event | 12 | $17,280 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $185,787 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

**Attachment A-1**
**Jewel Drive/OPWD DAPL Pool (Alternative 2A) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| **Present Value Analysis** | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $332,220 | 1.0000 | $ 332,220 |
| Annual Costs - Year 1 | 1 | $185,787 | 0.9346 | $ 173,633 |
| Annual Costs - Year 2 | 2 | $185,787 | 0.8734 | $ 162,274 |
| Annual Costs - Year 3 | 3 | $185,787 | 0.8163 | $ 151,658 |
| Annual Costs - Year 4 | 4 | $185,787 | 0.7629 | $ 141,736 |
| 5-Year Periodic Costs - Year 5 | 5 | $20,000 | 0.7130 | $ 14,260 |
| Annual Costs - Year 5 | 5 | $185,787 | 0.7130 | $ 132,464 |
| Annual Costs - Year 6 | 6 | $185,787 | 0.6663 | $ 123,798 |
| Annual Costs - Year 7 | 7 | $185,787 | 0.6227 | $ 115,699 |
| Annual Costs - Year 8 | 8 | $185,787 | 0.5820 | $ 108,130 |
| Annual Costs - Year 9 | 9 | $185,787 | 0.5439 | $ 101,056 |
| Annual Costs - Year 10 | 10 | $185,787 | 0.5083 | $ 94,445 |
| 5-Year Periodic Costs - Year 10 | 10 | $10,000 | 0.5083 | $ 5,083 |
| Annual Costs - Year 11 | 11 | $185,787 | 0.4751 | $ 88,266 |
| Annual Costs - Year 12 | 12 | $185,787 | 0.4440 | $ 82,492 |
| Annual Costs - Year 13 | 13 | $0 | 0.4150 | $ - |
| Annual Costs - Year 14 | 14 | $0 | 0.3878 | $ - |
| Annual Costs - Year 15 | 15 | $0 | 0.3624 | $ - |
| 5-Year Periodic Costs - Year 15 | 15 | $10,000 | 0.3624 | $ 3,624 |
| Total: | | $2,220,092 | | $1,656,455 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

# Attachment A-2
# Jewel Drive/OPWD DAPL Pool (Alternative 2B) Costs
# Olin Chemical Superfund Site
# Wilmington, Massachusetts


| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Replacement DAPL Extraction Well | $45,000 | LS | 1 | $45,000 |
| Geophysical Investigation | $15,000 | LS | 1 | $15,000 |
| Additional DAPL Extraction Well(s) | | | | |
| Mobilization | $16,000 | LS | 1 | $16,000 |
| Temporary Facilities and Controls | $13,500 | LS | 1 | $13,500 |
| Pump Enclosure Vault | $31,000 | LS | 3 | $93,000 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 3 | $93,000 |
| Underground DAPL Discharge Piping | $168 | LF | 300 | $50,400 |
| Electrical and Instrumentation Systems | $175,000 | LS | 0.5 | $87,500 |
| Multi-Port Monitoring Wells | $35,000 | LS | 6 | $210,000 |
| Induction Logging Wells | $8,000 | LS | 6 | $48,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $626,400 |
| Contingency | | | 20% | $125,280 |
| Total Capital Costs | | | | $811,680 |
| **Annual Costs** | | | | |
| Electricity | $1,800 | month | 12 | $21,600 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 420,480 | $550,829 |
| System Performance Monitoring | $2,880 | event | 12 | $34,560 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $626,989 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

**Attachment A-2**
**Jewel Drive/OPWD DAPL Pool (Alternative 2B) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| **Present Value Analysis** | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $811,680 | 1.0000 | $ 811,680 |
| Annual Costs - Year 1 | 1 | $626,989 | 0.9346 | $ 585,971 |
| Annual Costs - Year 2 | 2 | $626,989 | 0.8734 | $ 547,636 |
| Annual Costs - Year 3 | 3 | $313,494 | 0.8163 | $ 255,905 |
| Annual Costs - Year 4 | 4 | $0 | 0.7629 | $ - |
| 5-Year Periodic Costs - Year 5 | 5 | $20,000 | 0.7130 | $ 14,260 |
| Annual Costs - Year 5 | 5 | $0 | 0.7130 | $ - |
| Annual Costs - Year 6 | 6 | $0 | 0.6663 | $ - |
| Annual Costs - Year 7 | 7 | $0 | 0.6227 | $ - |
| Annual Costs - Year 8 | 8 | $0 | 0.5820 | $ - |
| Annual Costs - Year 9 | 9 | $0 | 0.5439 | $ - |
| Annual Costs - Year 10 | 10 | $0 | 0.5083 | $ - |
| 5-Year Periodic Costs - Year 10 | 10 | $0 | 0.5083 | $ - |
| Annual Costs - Year 11 | 11 | $0 | 0.4751 | $ - |
| Annual Costs - Year 12 | 12 | $0 | 0.4440 | $ - |
| Annual Costs - Year 13 | 13 | $0 | 0.4150 | $ - |
| Annual Costs - Year 14 | 14 | $0 | 0.3878 | $ - |
| Annual Costs - Year 15 | 15 | $0 | 0.3624 | $ - |
| 5-Year Periodic Costs - Year 15 | 15 | $0 | 0.3624 | $ - |
| Total: | | $2,399,152 | | $2,215,452 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details. Annual electricity, monitoring costs (red) assumed to double for additional pumping well scenario.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%. Calculated pumping rate shown below.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

| | | |
|---|---|---|
| target pumping rate: | 1 | gpm |
| operating time: | 80% | |
| planned pumping rate: | 420,480 | gal/year |

| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Remedial Design | $40,000 | LS | 1 | $40,000 |
| DAPL Extraction System Installation | | | | |
| Mobilization | $15,000 | LS | 1 | $15,000 |
| Temporary Facilities and Controls | $16,000 | LS | 1 | $16,000 |
| Pump Enclosure Vault | $13,500 | LS | 1 | $13,500 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 1 | $31,000 |
| Underground DAPL Discharge Piping | $140 | LF | 0 | $0 |
| Above Grade DAPL Discharge Piping - Field Fabricated | $168 | LF | 350 | $58,800 |
| Above Grade DAPL Discharge Piping - Prefabricated | $215 | LF | 0 | $0 |
| DAPL Storage Tank | $72,000 | LS | 1 | $72,000 |
| Inspection/Cleanout Structures | $6,125 | each | 1 | $6,125 |
| Leak Detection Manhole | $5,800 | LS | 1 | $5,800 |
| Tank Unloading Piping | $7,500 | LS | 0 | $0 |
| Above Grade Pipe Support Systems | $38,750 | LS | 0.5 | $19,375 |
| Railroad Crossing | $12,000 | LS | 0 | $0 |
| Chain Link Fence Single (Man) Gates | $750 | each | 0 | $0 |
| Electrical and Instrumentation Systems | $175,000 | LS | 0.25 | $43,750 |
| Multi-Port Monitoring Wells | $35,000 | LS | 2 | $70,000 |
| Induction Logging Wells | $8,000 | LS | 2 | $16,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $382,350 |
| Contingency | | | 20% | $76,470 |
| Total Capital Costs | | | | $498,820 |
| **Annual Costs** | | | | |
| Electricity | $900 | month | 12 | $10,800 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 105,120 | $137,707 |
| System Performance Monitoring | $1,440 | event | 12 | $17,280 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $185,787 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

**Attachment A-3**
**Containment Area DAPL Pool (Alternative 3A) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Present Value Analysis | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $498,820 | 1.0000 | $ 498,820 |
| Annual Costs - Year 1 | 1 | $185,787 | 0.9346 | $ 173,633 |
| Annual Costs - Year 2 | 2 | $185,787 | 0.8734 | $ 162,274 |
| Annual Costs - Year 3 | 3 | $92,894 | 0.8163 | $ 75,829 |
| Annual Costs - Year 4 | 4 | $0 | 0.7629 | $ - |
| Annual Costs - Year 5 | 5 | $0 | 0.7130 | $ - |
| 5-Year Periodic Costs - Year 5 | 5 | $20,000 | 0.7130 | $ 14,260 |
| Total: | | $983,288 | | $924,815 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

**Attachment A-4**
**Containment Area DAPL Pool (Alternative 3B) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Remedial Design | $40,000 | LS | 1 | $40,000 |
| DAPL Extraction System Installation | | | | |
| Mobilization | $15,000 | LS | 1 | $15,000 |
| Temporary Facilities and Controls | $16,000 | LS | 1 | $16,000 |
| Pump Enclosure Vault | $13,500 | LS | 4 | $54,000 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 4 | $124,000 |
| Underground DAPL Discharge Piping | $140 | LF | 0 | $0 |
| Above Grade DAPL Discharge Piping - Field Fabricated | $168 | LF | 600 | $100,800 |
| Above Grade DAPL Discharge Piping - Prefabricated | $215 | LF | 0 | $0 |
| DAPL Storage Tank | $72,000 | LS | 1 | $72,000 |
| Inspection/Cleanout Structures | $6,125 | each | 1 | $6,125 |
| Leak Detection Manhole | $5,800 | LS | 1 | $5,800 |
| Tank Unloading Piping | $7,500 | LS | 0 | $0 |
| Above Grade Pipe Support Systems | $38,750 | LS | 0.5 | $19,375 |
| Railroad Crossing | $12,000 | LS | 0 | $0 |
| Chain Link Fence Single (Man) Gates | $750 | each | 0 | $0 |
| Electrical and Instrumentation Systems | $175,000 | LS | 0.25 | $43,750 |
| Multi-Port Monitoring Wells | $35,000 | LS | 7 | $245,000 |
| Induction Logging Wells | $8,000 | LS | 7 | $56,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $772,850 |
| Contingency | | | 20% | $154,570 |
| Total Capital Costs | | | | $967,420 |
| **Annual Costs** | | | | |
| Electricity | $1,800 | month | 12 | $21,600 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 420,480 | $550,829 |
| System Performance Monitoring | $2,880 | event | 12 | $34,560 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $626,989 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

| Present Value Analysis | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $967,420 | 1.0000 | $ 967,420 |
| Annual Costs - Year 1 | 1 | $626,989 | 0.9346 | $ 585,971 |
| Annual Costs - Year 2 | 2 | $0 | 0.8734 | $ - |
| Annual Costs - Year 3 | 3 | $0 | 0.8163 | $ - |
| Annual Costs - Year 4 | 4 | $0 | 0.7629 | $ - |
| Annual Costs - Year 5 | 5 | $0 | 0.7130 | $ - |
| 5-Year Periodic Costs - Year 5 | 10 | $20,000 | 0.5083 | $ 10,167 |
| Total: | | $1,614,409 | | $1,563,558 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details. Annual electricity, monitoring costs (red) assumed to double for additional pumping well scenario.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%. Calculated pumping rate shown below.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

| | | |
|---|---|---|
| target pumping rate: | 1 | gpm |
| operating time: | 80% | |
| planned pumping rate: | 420,480 | gal/year |

**Attachment A-5**
**Main Street DAPL Pool (Alternative 4A) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Geophysical Investigation | $30,000 | LS | 1 | $30,000 |
| Remedial Design | $60,000 | LS | 1 | $60,000 |
| Additional DAPL Extraction Well(s) | | | | |
| Mobilization | $20,000 | LS | 1 | $20,000 |
| Temporary Facilities and Controls | $16,000 | LS | 1 | $16,000 |
| Pump Enclosure Vault | $13,500 | LS | 3 | $40,500 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 3 | $93,000 |
| Underground DAPL Discharge Piping | $140 | LF | 2000 | $280,000 |
| Above Grade DAPL Discharge Piping | $200 | LF | 550 | $110,000 |
| DAPL Storage Tank | $72,000 | LS | 2 | $144,000 |
| Inspection/Cleanout Structures | $6,125 | each | 8 | $49,000 |
| Leak Detection Manhole | $5,800 | LS | 1 | $5,800 |
| Tank Unloading Piping | $7,500 | LS | 2 | $15,000 |
| Above Grade Pipe Support Systems | $38,750 | LS | 1 | $38,750 |
| Railroad Crossing | $12,000 | LS | 1 | $12,000 |
| Chain Link Fence Single (Man) Gates | $750 | each | 0 | $0 |
| Electrical and Instrumentation Systems | $262,500 | LS | 1 | $262,500 |
| Multi-Port Monitoring Wells | $35,000 | LS | 3 | $105,000 |
| Induction Logging Wells | $8,000 | LS | 3 | $24,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $1,230,550 |
| Contingency | | | 20% | $246,110 |
| Total Capital Costs | | | | $1,566,660 |
| **Annual Costs** | | | | |
| Electricity | $900 | month | 12 | $10,800 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 630,720 | $826,243 |
| System Performance Monitoring | $4,320 | event | 12 | $51,840 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $908,883 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

**Attachment A-5**
**Main Street DAPL Pool (Alternative 4A) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Present Value Analysis | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $1,566,660 | 1.0000 | $ 1,566,660 |
| Annual Costs - Year 1 | 1 | $908,883 | 0.9346 | $ 849,424 |
| Annual Costs - Year 2 | 2 | $908,883 | 0.8734 | $ 793,854 |
| Annual Costs - Year 3 | 3 | $908,883 | 0.8163 | $ 741,919 |
| Annual Costs - Year 4 | 4 | $908,883 | 0.7629 | $ 693,383 |
| 5-Year Periodic Costs - Year 5 | 5 | $20,000 | 0.7130 | $ 14,260 |
| Annual Costs - Year 5 | 5 | $908,883 | 0.7130 | $ 648,021 |
| Annual Costs - Year 6 | 6 | $908,883 | 0.6663 | $ 605,627 |
| Annual Costs - Year 7 | 7 | $908,883 | 0.6227 | $ 566,007 |
| Annual Costs - Year 8 | 8 | $908,883 | 0.5820 | $ 528,978 |
| Annual Costs - Year 9 | 9 | $908,883 | 0.5439 | $ 494,372 |
| Annual Costs - Year 10 | 10 | $908,883 | 0.5083 | $ 462,030 |
| 5-Year Periodic Costs - Year 10 | 10 | $20,000 | 0.5083 | $ 10,167 |
| Annual Costs - Year 11 | 11 | $908,883 | 0.4751 | $ 431,804 |
| Annual Costs - Year 12 | 12 | $908,883 | 0.4440 | $ 403,555 |
| Annual Costs - Year 13 | 13 | $908,883 | 0.4150 | $ 377,154 |
| Annual Costs - Year 14 | 14 | $908,883 | 0.3878 | $ 352,481 |
| Annual Costs - Year 15 | 15 | $908,883 | 0.3624 | $ 329,421 |
| 5-Year Periodic Costs - Year 15 | 15 | $20,000 | 0.3624 | $ 7,249 |
| Annual Costs - Year 16 | 16 | $908,883 | 0.3387 | $ 307,870 |
| Annual Costs - Year 17 | 17 | $908,883 | 0.3166 | $ 287,729 |
| Annual Costs - Year 18 | 18 | $908,883 | 0.2959 | $ 268,906 |
| Annual Costs - Year 19 | 19 | $908,883 | 0.2765 | $ 251,314 |
| Annual Costs - Year 20 | 20 | $908,883 | 0.2584 | $ 234,873 |
| 5-Year Periodic Costs - Year 20 | 20 | $20,000 | 0.2584 | $ 5,168 |
| Total: | | $19,824,324 | | $11,232,226 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

| | | |
|---|---|---|
| target pumping rate: | 1.5 | gpm |
| operating time: | 80% | |
| planned pumping rate: | 630,720 | gal/year |

**Attachment A-6**
**Main Street DAPL Pool (Alternative 4B) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Description | Unit Cost | Units | Quantity | Extended Cost |
|---|---|---|---|---|
| **Capital Costs** | | | | |
| Limited Action - Deed Restriction Notification | $12,400 | LS | 0 | $0 |
| Geophysical Investigation | $30,000 | LS | 1 | $30,000 |
| Remedial Design | $60,000 | LS | 1 | $60,000 |
| Additional DAPL Extraction Well(s) | | | | |
| Mobilization | $20,000 | LS | 1 | $20,000 |
| Temporary Facilities and Controls | $16,000 | LS | 1 | $16,000 |
| Pump Enclosure Vault | $13,500 | LS | 12 | $162,000 |
| Extraction Pump, Controls and Pump Enclosure Piping | $31,000 | LS | 12 | $372,000 |
| Underground DAPL Discharge Piping | $140 | LF | 3000 | $420,000 |
| Above Grade DAPL Discharge Piping | $200 | LF | 550 | $110,000 |
| DAPL Storage Tank | $72,000 | LS | 2 | $144,000 |
| Inspection/Cleanout Structures | $6,125 | each | 8 | $49,000 |
| Leak Detection Manhole | $5,800 | LS | 1 | $5,800 |
| Tank Unloading Piping | $7,500 | LS | 2 | $15,000 |
| Above Grade Pipe Support Systems | $38,750 | LS | 1 | $38,750 |
| Railroad Crossing | $12,000 | LS | 1 | $12,000 |
| Chain Link Fence Single (Man) Gates | $750 | each | 0 | $0 |
| Electrical and Instrumentation Systems | $262,500 | LS | 1 | $262,500 |
| Multi-Port Monitoring Wells | $35,000 | LS | 24 | $840,000 |
| Induction Logging Wells | $8,000 | LS | 24 | $192,000 |
| System Start-up and Prove-Out | $15,000 | LS | 1 | $15,000 |
| Subtotal | | | | $2,674,050 |
| Contingency | | | 20% | $534,810 |
| Total Capital Costs | | | | $3,298,860 |
| **Annual Costs** | | | | |
| Electricity | $1,800 | month | 12 | $21,600 |
| O&M Labor | $30,000 | LS | 0 | $0 |
| DAPL on-site treatment: capital, O&M and solids disposal | $1.31 | gallons | 2,522,880 | $3,304,973 |
| System Performance Monitoring | $8,640 | event | 12 | $103,680 |
| Monitoring and Performance Reports | $20,000 | LS | 1 | $20,000 |
| Total Annual Costs | | | | $3,450,253 |
| **5-Year Periodic Costs** | | | | |
| 5-Year Review Report | $20,000 | LS | 1 | $20,000 |
| Deed Restriction Verification and Maintenance | $5,000 | LS | 0 | $0 |

**Attachment A-6**
**Main Street DAPL Pool (Alternative 4B) Costs**
**Olin Chemical Superfund Site**
**Wilmington, Massachusetts**


| Present Value Analysis | | | | |
|---|---|---|---|---|
| **Cost Type** | **Year** | **Total Cost** | **Discount Factor** | **Present Value** |
| Capital Costs - Year 0 | 0 | $3,298,860 | 1.0000 | $ 3,298,860 |
| Annual Costs - Year 1 | 1 | $3,450,253 | 0.9346 | $ 3,224,535 |
| Annual Costs - Year 2 | 2 | $3,450,253 | 0.8734 | $ 3,013,584 |
| Annual Costs - Year 3 | 3 | $3,450,253 | 0.8163 | $ 2,816,434 |
| Annual Costs - Year 4 | 4 | $3,450,253 | 0.7629 | $ 2,632,181 |
| 5-Year Periodic Costs - Year 5 | 5 | $20,000 | 0.7130 | $ 14,260 |
| Annual Costs - Year 5 | 5 | $3,450,253 | 0.7130 | $ 2,459,983 |
| Annual Costs - Year 6 | 6 | $1,725,126 | 0.6663 | $ 1,149,525 |
| Annual Costs - Year 7 | 7 | $0 | 0.6227 | $ - |
| Annual Costs - Year 8 | 8 | $0 | 0.5820 | $ - |
| Annual Costs - Year 9 | 9 | $0 | 0.5439 | $ - |
| Annual Costs - Year 10 | 10 | $0 | 0.5083 | $ - |
| 5-Year Periodic Costs - Year 10 | 10 | $10,000 | 0.5083 | $ 5,083 |
| Annual Costs - Year 11 | 11 | $0 | 0.4751 | $ - |
| Annual Costs - Year 12 | 12 | $0 | 0.4440 | $ - b |
| Annual Costs - Year 13 | 13 | $0 | 0.4150 | $ - |
| Annual Costs - Year 14 | 14 | $0 | 0.3878 | $ - |
| Annual Costs - Year 15 | 15 | $0 | 0.3624 | $ - |
| 5-Year Periodic Costs - Year 15 | 15 | $0 | 0.3624 | $ - |
| Total: | | $22,305,250 | | $18,614,445 |

Notes:

1. See IAFS (Wood, 2019) for unit cost assumption details. Annual electricity, monitoring costs (red) assumed to double for additional pumping well scenario.
2. Annual pumping rate based on pumping rate provided (GPM) at an operating time of 80%. Calculated pumping rate shown below.
3. Years of operation rounded up to nearest half year for annual costs.
4. Present value based on a 7% discount rate.
5. DAPL per-gallon treatment cost provided by Olin is assumed to include all construction, infrastructure, and O&M associated with design and implementation of on-site treatment.

| | | |
|---|---|---|
| target pumping rate: | 6 | gpm |
| operating time: | 80% | |
| planned pumping rate: | 2,522,880 | gal/year |

**ATTACHMENT B**

DAPL Treatment Train

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Below is the list of assumptions developed by Olin Corporation to develop the on-site dense aqueous phase liquid (DAPL) treatment train and cost estimates. This list was sent to the U.S. Environmental Protection Agency (EPA) on Wednesday, February 12, 2020 and is incorporated in the DAPL Alternatives Comparison Memo.

- Estimated on-Site DAPL treatment cost: **$1.31/gallon** [assumed volume within the three DAPL pools: 15,000,000 gallons]. The cost includes capital, operations and maintenance (O&M), and sludge/solids disposal. Cost does not include labor.
- DAPL Treatment train: Lime precipitation of metals and dewatering/disposal of sludge; Stripping of volatile organic compounds (VOCs) and ammonia; ultraviolet (UV) photooxidation of n-nitrosodimethylamine (NDMA); and evaporation of remaining water and disposal of the resulting residual solids.
- Sludge cake (metals precipitate) and evaporated solids will be non-hazardous.
- Transport and disposal of solids/sludge: $100/ton.
- Average sulfate concentration in DAPL: 20,000 mg/L, based on available data.
- Air stripper will be designed for 99.9% ammonia removal, as NDMA removal is assumed to be required in the downstream process.
- Effluent ammonia concentration from ammonia stripper will be low enough to avoid issues with NDMA removal.
- 95% UV transmittance in the influent.
- DAPL will be evaporated to 20% of its original volume and will be a solid for off-site transportation/disposal.
- Evaporated solids will have a specific gravity of 1.5.

Note - The feasibility of constructing a full-scale DAPL treatment system will have to be verified/confirmed during a pilot test and/or bench-scale study.